



INDIAN CENTRAL JUTE COMMITTEE

**Annual Report of the Jute Agricultural
Research Institute (1953-54)**

Calcutta

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ANNUAL REPORT OF THE JUTE AGRICULTURAL RESEARCH INSTITUTE (1953-54)

Introduction

An area of 55 acres out of the 101.44 acres of land of the farm was under cultivation. Out of this area only 33 acres was suitable for experimental purposes. Practically the whole of the cultivable land is high and is not quite suitable for double and triple cropping experiments with jute, paddy and pulses, as well as for green manuring experiments. The Committee agreed to the proposal of the Director, Jute Agricultural Research Institute for acquiring an area of 50 acres of low and mid lands adjacent to the farm for carrying out these experiments. Negotiations for acquiring the proposed area through the Agricultural Department of West Bengal Government are in progress.

Shortage of skilled labour was greatly felt throughout the season and proved a great handicap in the smooth running of the work. Shortage of retting facilities was also very acute and to cope with the retting work of the farm, necessary arrangements to use the water of the canal running along the farm boundary for the purpose were made with the kind permission of the Irrigation Department of the Government of West Bengal. As in previous year, during this year also, farm work greatly suffered for lack of essential farm structures. Since the inception of farm at Nilganj, makeshift arrangements are continuing for housing bullocks, storing seeds, manures, fibres, etc.

Besides normal research work, a model scheme on 'Improvement of green manuring crops' sanctioned and financed by the Indian Council of Agricultural Research for a period of 5 years was taken up.

To popularise the improved methods of cultivation among the local agriculturists, a pilot scheme on "Extension of improved methods of jute cultivation" was initiated during the year under report. The work consisted in the introduction of line sowing of jute, use of manures and improved jute

strains, practice of double and triple cropping in the cultivators' plots at Barrackpore, Baraset and Basirhat centres of 24-parganas in West Bengal. The demonstrations were effective and the cultivators were convinced of the extra profit that can be derived from improved jute cultivation.

Besides jute, other crops including substitute fibre crops were grown and studied in both kharif and rabi seasons, the Important ones being mesta, roselle, sunn-hemp, paddy, cowpea, pillipesara, some fodder and green manuring crops. The winter crops were wheat, barley, potato, mustard, linseed and pulses.

Season

The season was somewhat late and was not very favourable for jute under Nilganj conditions. The experimental sowings were started by the latter part of April due to late rains. A prolonged drought which began soon after sowings, continued for a period of more than 3 weeks and affected the jute crop considerably, resulting in the drying up of some seedlings. The continued rain following the drought also interfered with timely intercultural operations. The crops, however, revived in the later stages of growth. The general weather conditions were quite favourable for paddy crop during the year under report. Insect attack, particularly of semi-looper, was reported from most of the jute growing areas. Necessary remedial measures were taken to control the pests from experimental crops.

Development of the Jute Agricultural Research Institute at Nilganj

The development of the Jute Agricultural Research Institute at Nilganj has been taken up in two phases. The first phase of the work which was sanctioned in 1952 consisted in the construction of the ground floor of the Institute building and six 'C' type, twelve 'H' type and twenty 'G' type quarters meant respectively for assistants, clerks or fieldmen or junior assistants, and Class IV staff. The staff quarters have been completed, but for want of supply of electricity and

water these could not be occupied. The ground floor of the Institute building is nearing completion, but the progress of construction has been, unfortunately, very slow.

Second phase of the work consists in the construction of the first floor of the Institute building, a Lecture Hall, a Hostel for trainees from different jute growing States, and staff quarters for all staff (except for those recruited or to be recruited under the Expansion Scheme). The plan of the first floor of the Institute building has already been modified and those for the staff quarters and the Hostel have been prepared by the Chief Architect, C.P.W.D., Government of India. The construction work has not as yet been undertaken.

The Agricultural Research Sub-Committee of the Indian Central Jute Committee appointed a Sub-Committee consisting of Dr. J. N. Mukherjee as Chairman, Mr. L. P. Singhania, Prof. S. P. Agharkar, Dr. H. K. Nandi, Director of Agriculture, West Bengal, Dr. J. S. Patel, Director of Agriculture, Bihar and Dr. B. C. Kundu, Director, Jute Agricultural Research Institute, to go into the question of extension of activities of the Jute Agricultural Research Institute as proposed by the Director, Jute Agricultural Research Institute. The Sub-Committee among other things recommended that six research-cum-development sub-stations should be established:

- (i) One at Nowgong (Assam),
- (ii) One at Purnea (Bihar),
- (iii) One in D.V.C. irrigation areas in Burdwan (West Bengal),
- (iv) One at Kendrapara (Orissa),
- (v) One at Lakhimpur-Kheri (U.P.), and
- (vi) One at Jalpaiguri (North Bengal).

The Sub-Committee fixed the order of priority for establishment of these stations and recommended that Nos. (i) to (iii) should be started in the first year, (iv) and (v) in the second year and (vi) in the third year.

The recommendations of the Expert Committee for the expansion of the research work, the establishment of research-cum-development substations were approved by the Indian Central Jute Committee at its meeting held on the 15th September, 1953 and were later sanctioned by the Government of India. On account of paucity of funds no substation could be established in 1954-55, but they are expected to be developed according to programme from the 1955-56 session.

Nucleus Seed Multiplication Farm.—The Expert Committee set up by the Government of India for the improvement of the quality of Indian jute recommended, among other measures, the establishment of eight Seed Multiplication Farms—3 in West Bengal, 3 in Bihar and one each in Orissa and U.P. for the multiplication of the improved strains evolved by the Jute Agricultural Research Institute. The Committee also suggested that a Nucleus Seed Multiplication Farm should be established under the auspices of the Jute Agricultural Research Institute of the Indian Central Jute Committee for the production of nucleus seeds to be supplied to the State Seed Multiplication Farms. A plot of land measuring about 200 acres at Panagarh was selected for this purpose. Government of India sanctioned a sum of Rs. 4,48,189/- for setting up this farm in 1954-55. Steps were taken for getting this land in time so that seed multiplication could start from this year. Unfortunately as the land could not be made available to us in time, work could not be started this year.

I. BREEDING AND GENETICS OF JUTE

1. Collection of Varieties and Types

Eight indigenous samples of jute seeds, five *capsularis* and three *olitorius*, were sown during the season. The growth performance of all except a *capsularis* type from Saharanpur, U.P. was like normal cultivated types. The seeds from Saharanpur were smaller than those of the cultivated types and the plants raised from them were under two feet in height showing features characteristic of wild types. In all 39

primary selections were made from these types for further studies.

Seven exotic samples of seeds were received and grown during the year. These included five *capsularis* and two *olitorius* types. Of the *capsularis* types four were from Bangkok and one from Nepal. The type from Nepal failed to germinate. In one of the plots sown with seeds from Bangkok, there was a mixture of wild and cultivated types and in another a mixture of *capsularis* and *olitorius* was observed. Plants in this and the remaining two plots were found to be of cultivated types. Seventeen primary selections were made in these four plots. Of the two *olitorius* types, the one from Nepal failed to germinate; from the other type, obtained from Portugal, a few plants, bushy in habit like wild *olitorius* types and very late in maturity, were raised. Some selections were made to carry forward the type, but none of the plants set capsules due, apparently, to a disease which seemed to inhibit setting.

Wild species of Corchorus.—During the year one sample of *C. depressus* and one of *C. tridens* were received from Allahabad and Coimbatore respectively. The former failed to germinate, while the latter gave only a few plants which were studied and confirmed as *C. tridens*.

There are at present in our collection seven wild species of *Corchorus* including wild forms of *C. capsularis* and *C. olitorius*. We have so far collected five wild forms of *C. capsularis*, viz., (1) Maniksari from Chittagong Hill Tracts, (2) a type from Bombay Coast, (3) a Midnapore type, (4) a Bangkok type and (5) a type from Saharanpur, U.P. The wild forms of *C. olitorius* are classified into two distinct forms, viz., (1) Full green and (2) Light-red. We have two types of *C. trilocularis*, viz., (1) a Bombay type and (2) a Saurashtra type. The other four species in our collection are *C. acutangulus*, *C. fascicularis*, *C. tridens* and *C. siliquosus*.

2. Breeding of Jute

Progeny-row tests.—Nine progeny-row trials, six *capsularis* and three *olitorius*, were carried out during the year.

The *capsularis* trials included three first year trials, one second year trial, one combined trial of second year and multiple-cross materials and a trial of X-irradiated materials of the previous year. The *olitorius* trials included one first year trial, one trial of selections from X-irradiated materials and a trial of polyploid materials. Due to a prolonged period of drought in May, germination in the earlier sown trials suffered and there were deaths of seedlings. As a result, the final stand in these trials ranged from fair to poor. The trials of X-irradiated *capsularis* and *olitorius* materials, that were sown late, escaped the drought and good stand was recorded in them. Germination, pigmentation, periodical vigour performance, flowering and other records were taken in all the trials. The trials were harvested culture-wise at the small pod stage. A total of 3572 secondary selections were made in these trials. Pigmentation, date of first flowering, height, base diameter etc. were recorded for the individual selections.

First year test of selections: (i) Capsularis.—78 promising selections obtained from various sources were tested in three randomized block trials. The first trial included the promising branching selections, the second trial consisted of the non-branching materials and the third all the miscellaneous materials. All the three trials were harvested and their stand and yield data recorded. 1144 secondary selections were made for further study. On the results of analysis of stand and yield data, 12 cultures that were as good as or slightly higher than the control in yield but possessed desirable characters like earliness, non-branching habit etc. were carried forward.

(ii) Olitorius.—A first year test of 24 selections of which 18 were primary selections from Indian and foreign types and four were selections from hybrid and two from X-irradiated materials along with controls, was carried out in a randomized block layout during the year. Germination was considerably affected by the drought in May. The trial was, however, harvested after leaving 448 secondary selections for further studies. The stand and yield data were analysed. On the basis of analysis three cultures that were significantly superior to the control, C. G., in yield and six more, that were

as good as the control were carried forward for studies during the next jute season.

Second year test of selections: (i) Capsularis.—Five families of five progenies each brought forward from the first year trials of the previous year and five selections of a promising foreign material were tested along with controls in a compact family block trial in eight replications. Germination in the different plots ranged from fair to poor and the growth of the crop was fair. The trial was harvested and the stand and yield data were recorded. On the result of analysis of the yield data only three progenies of one of the families were carried forward.

Capsularis combined second year and multiple-cross materials trial.—Six families, four at the second year stage and two from the multiple-cross materials of the previous year, each consisting of five progenies, were tested along with controls in a compact family block layout. Germination in the different plots ranged from fair to poor but the growth was good. The trial was harvested for fibre after making 396 secondary selections for further studies. The data were analysed and on the basis of analysis three progenies from a foreign material and two from multiple-crossing materials were carried forward.

(ii) Olitorius.—There was no *olitorius* material at the second year stage.

Test of selections from X-irradiated materials: (i) Capsularis.—30 selections made during the previous year in plots of C39-212 sown with pre-soaked and dry seeds treated with different doses of both soft and hard X-rays, were tested along with controls in a randomized block layout. Germination was good in almost all the plots and the growth was normal. The trial was harvested and the stand and yield data were recorded. 384 secondary selections were made for further studies. On the results of analysis of the yield data 10 cultures that were statistically as good as the control but recorded higher yield were carried forward for further tests during the next jute season.

(ii) *Olitorius*.—22 selections made in the plots of O40-632 raised from pre-soaked and dry seeds treated with different doses of both soft and hard rays, were tested in a randomized block layout. Germination was good and the trial was harvested after making 288 secondary selections for further studies. The stand and yield data were recorded. On the analysis of the yield data only one culture which was statistically as good as control O40-632, but yielded slightly higher was carried forward.

Yield trial of olitorius polyploids.—As in the previous year a yield trial of *olitorius* polyploids was carried out in a compact family block layout. There were six families of five progenies each in the trial besides controls. The tetraploids recorded lower germination than the controls. The trial was harvested and the yield data were analysed. On the results of analysis all the tetraploid families were rejected, being much inferior to the controls in yield.

Varietal trials.—Two varietal trials, one *capsularis* and one *olitorius*, were carried out during the year.

Capsularis.—A fresh trial of *capsularis* was started for a period of three years commencing from the year under report. It included eight varieties, viz. C39-212, C41-13, C42-Kj-321, JR48-1, C.T.918, C.T.919, Fanduk (early control) and D154 (late control). It may be stated here that the varieties Orissa 6J and Jap Red did not perform well in trials conducted during the previous years. They were, therefore, replaced with two promising varieties C.T.918 and C.T.919. The trial was sown in the first week of May. Germination was good and uniform in all the plots. But this was followed by a prolonged period of drought which affected the plants adversely. Later there was an attack of semi-looper which also damaged the crop considerably. The crop, however, recovered from these damages at the later stages of growth and made up the initial setback to some extent. The varieties were harvested separately at the small pod stage and their stand and yield data recorded. The yield data were analysed. The results are given in the Table below

along with dates of first flowering and quality ratios for the different varieties:—

TABLE I

Capsularis Varietal Trial

Layout—Randomized blocks in 6 replications.

Gross plot size—1/44 acre (33' × 30'). Effective plot size—1/57.77 acre (29' × 26').

Date of sowing 5.5.53. Harvested between 21.8.53 and 27.10.53 at small pod stage.

Variety	Yield per acre (Mds.)	Per cent on control.	Date of 1st flower.	Quality ratio.
C39-212	27.18	110.58	16.8.53	90 ± 0.9
C.T. 919	26.67	108.50	21.9.53	80 ± 1.5
JR48-1	25.99	105.74	19.8.53	89 ± 1.1
C41-13	25.64	104.31	22.8.53	91 ± 1.6
D154	24.58	100.00	17.8.53	90 ± 1.2
C. T. 918	22.28	90.64	25.8.53	89 ± 1.4
Fanduk	19.90	80.96	2.8.53	103 ± 1.6
C42-Kj-321	19.18	78.03	27.7.53	96 ± 1.6

P. 0.01

C.D. 3.50

S.E.% 3.79

From the Table above it may be seen that C39-212 has topped the list yielding about 11 per cent higher than the control (D154); C.T.919 yielding about 8 per cent higher comes next though they are statistically as good as the control. JR48-1 and C41-13 yielding about 6 and 4 per cent respectively higher than the control are also in the same group with the control.

As in the previous years the early varieties Fanduk and C42-Kj-321 maintained their superiority over the late varieties in quality ratio.

Olitorius.—The *olitorius* varietal trial was continued as before with the varieties O40-632, O40-753, O39-620, R26 and C.G. (control). The trial was sown in the first week of May in good moisture condition of the soil and the germination was good and uniform. This trial also suffered due to the prolonged drought that followed sowing and the subsequent damage by semi-looper. During the later stages of growth, the crop, however, recovered considerably and the final stand and the performance of the plants were fairly satisfactory. The varieties were harvested separately at the small pod stage and the stand and yield data recorded. The yield data were analysed. The results are given below along with the dates of first flowering and quality ratios for different varieties.

TABLE II

Olitorius Varietal Trial

Layout—5 × 5 Latin Square.

Gross plot size—1/50 acre (35' × 25') approx. Effective plot size—1/67 acre (31' × 21') approx.

Date of sowing—5.5.53. Harvested between 2.9.53 and 16.9.53 at small pod stage.

Varieties	Yield per acre (Mds.)	Per cent on control	Date of 1st flower	Quality ratio
O40-753	27.86	123.38	14.8.53	95 ± 1.1
O39-620	26.69	118.20	12.8.53	97 ± 1.4
O40-632	26.67	118.11	24.8.53	93 ± 1.9
C. G.	22.58	100.00	16.8.53	99 ± 1.8
R26	21.03	93.14	6.8.53	100 ± 1.2
P	0.01			
C. D.	3.97			
S. E. %	3.68			

From the Table above, it may be seen that the improved strains O40-753, O39-620 and O40-632 evolved by the Jute Agricultural Research Institute are significantly superior to the control C.G., yielding about 23, 18 and 18 per cent respectively higher. From the maturity point of view, it may be seen that R26, O39-620 and O40-753 are ten, four and two days respectively earlier than C.G., while O40-632 is eight days later. As regards quality ratios the varieties do not show big differences and they all lie between 93 and 100.

Varietal trials in State Farms.—12 varietal trials, six *capsularis* and six *olitorius* were sown during the year in the jute growing States of West Bengal, Bihar, Assam, Orissa and U.P. There were four trials in West Bengal, two *capsularis* and two *olitorius* and the rest of the States had two trials each, one *capsularis* and one *olitorius*.

The *capsularis* varietal trials at Karimganj (Assam), Purnea (Bihar) and Gograghat (U.P.) farms failed due to adverse climatic conditions. The data of the trial at Kujang have not yet been received. The stand and yield data of Maynaguri and Cooch Behar (West Bengal) trials were scrutinized. The data of the trial at Cooch Behar were found to be vitiated by spreading the harvest of the same variety over a month and this was done for all the varieties in the trial. In the Maynaguri trial, three of the blocks suffered heavy damage due to storm and the stand was very poor in these blocks which in addition received differential manurial treatments.

The *olitorius* varietal trials at Chinsurah and Berhampore (West Bengal), Purnea (Bihar), Ballia (Orissa) and Gograghat (U.P.) farms failed due to late sowing which was followed by incessant rains causing water-logging in the plots. Only one trial at Dalgaon (Assam) farm gave good crop and was conducted properly till the stage of harvest. But this trial also had to be rejected as the data were vitiated by spreading the harvest of the same variety over a fortnight.

Subvention trials in cultivators' plots.—During the year under report 85 subvention trials were conducted in culti-

vators' plots of the five jute growing States. They were distributed as follows:—

State		<i>Capsularis</i>	<i>Olitorius</i>	Total
West Bengal	...	10	20	30
Bihar	...	10	6	16
Assam	...	10	6	16
Orissa	...	9	4	13
U. P.	...	7	3	10
Total	...	46	39	85

Most of the trials were inspected in the field during the crop season and the necessary particulars were noted and progress of the trials observed. 32 trials, 18 *capsularis* and 14 *olitorius* were successful and the rest either failed or were rejected due to various reasons. Results of analysis of the yield data from the successful trials are given in the Table below:—

TABLE III

State	Capsularis or Olitorius	No. of suc- cessful trials	Variety	Yield per acre in maunds	Per cent on control
W. Bengal	<i>Capsularis</i>	6	JR48-1	19.71	119.89
			D154	19.54	118.86
			C39-212	19.18	116.67
			C41-13	18.67	113.56
			Local	16.44	100.00
			P	0.05	
			C.D.	2.18	
			S.E. %	4.09	
	<i>Olitorius</i>	10	O40 632	21.38	130.60
			O39-620	19.43	118.69
			O40-753	19.14	116.92
			C.G.	17.34	105.93
			Local	16.37	100.00
			P	0.01	
			C.D.	2.83	
			S.E.%	4.05	

State	Capsularis or Olitorius	Number of success- ful trials	Variety	Yield per acre in maunds	Per cent on control
Bihar ...	<i>Capsularis</i>	2	Data inadequate for analysis.		
	<i>Olitorius</i>	1	Data inadequate for analysis.		
Assam ...	<i>Capsularis</i>	4	C42-Kj-321	19.74	126.46
			D154	17.29	110.76
			C39-212	17.15	109.87
			JR48-1	16.87	108.07
			Local	15.61	100.00
			P	0.01	
			C.D.	2.19	
			S.E.%	3.24	
	<i>Olitorius</i>	2	Data inadequate for analysis.		
Orissa ...	<i>Capsularis</i>	5	C41-13	20.33	114.15
			D154	19.46	109.26
			C39-212	19.04	106.91
			JR48-1	18.65	104.72
			Local	17.81	100.00
			P	Large	
	S.E.%	3.66			
<i>Olitorius</i>	nil				
U. P.	<i>Capsularis</i>	1	Data inadequate for analysis.		
	<i>Olitorius</i>	1	Data inadequate for analysis.		
Total ...	<i>Capsularis</i>	18 trials successful out of 46 trials sown.			
	<i>Olitorius</i>	14 trials successful out of 39 trials sown.			

It may be seen from the Table above that among *capsularis* improved strains, JR48-1 has given the best yield in West Bengal giving 20 per cent higher yield than the locals. C42-Kj-321, an early strain, proved best in Assam giving 26 per cent higher yield than the locals. In Orissa, C41-13 proved superior to the locals by 14 per cent in yield.

Among the *olitorius* improved strains, O40-632 has proved best in West Bengal yielding about 31 per cent higher than the locals. O39-620 and O40-753 have followed in order yielding about 19 and 17 per cent higher respectively than the locals.

*Polyploidy—1948 colchicine treated series: Capsularis—*Seeds from three selections, three pods from one and four from the other two, representing two of the 1948 treated plants were sown. Germination was extremely poor; only two plants were obtained, both the plants maintained the morphological features characteristic of polyploids. They flowered profusely; in one of the plants all the flowers shed and no capsule was obtained while the capsules obtained from the other contained only shrivelled up seeds that were not viable.

*1950 colchicine treated series : Capsularis—*Seeds of 11 progenies representing two of the original lines were sown. Germination was poor, below 20 per cent. The plants maintained the morphological characters of the polyploids. One of the progenies was sterile like the one of 1948 series and produced capsules that did not contain viable seeds. Single plant and bulk seeds, where available, were carried forward for further studies.

Olitorius.—19 selections, covering the four tetraploid lines of 1950, were sown. From pods collected from each of the selections only those containing the highest number of viable seeds were selected for sowing. This was done with a view to improve the fertility of the materials. Germination in three of the four lines ranged between 42 and 47 per cent and the fourth recorded only 29 per cent. All the progenies exhibited tetraploid features. A few plants in each of the three lines which recorded fair germination differed from the other plants

in being dwarf and weak. They had leaves that were slightly longer and narrower as compared to those of polyploids. Selections representing all the materials were carried forward for further studies.

A total of 131 selections was made in the *capsularis* and *olitorius* polyploid lines.

A large number of interspecific crosses between polyploid forms of the two species were attempted. Apparently normal looking capsules were obtained as a result of these crosses but none of them yielded any viable seeds.

Studies on irradiation of jute with X-rays: X₂ generation.—19 *capsularis* and 10 *olitorius* aberrant selections brought forward from the X₁ generation of the previous year were grown. All the selections were based on morphological variations like bifurcation of the stem, flattening of the stem tip and a wide range of leaf variations like narrow deeply serrated leaves, asymmetrical leaves, cohesion of closely set leaves etc. Among the *capsularis* selections only three cultures gave progenies that showed some degree of variation as compared to the normal. The first of these gave two progenies that were morphologically similar to the V₂ mutant while the rest could not be differentiated from the normal. The progenies of the second culture segregated into normal and albino seedlings; the albino seedlings later perished. The third gave progenies which initially had deeply serrated leaves but at the later stages of growth produced only normal leaves.

The *olitorius* cultures were marked by absence of noticeable variations in their early stages of growth. As the vegetative phase advanced a few plants in three of the cultures were conspicuous by their poor growth. These plants produced short stumpy capsules and had a prolonged period of flowering which ended about a month after the flowering ceased in normal plants.

44 selections were made from the *capsularis* and *olitorius* cultures for further studies.

Fresh treatments.—Seeds of *capsularis* (C39-212) and *olitorius* (O40-632) were treated afresh during the year. Both dry and presoaked seeds were treated with eight different doses of soft rays. The dosages for the dry seeds ranged between 5000r and 40,000r units while for the presoaked seeds they were between 1000r and 30,000r units. Germination of the treated seeds was fair in all the treatments except 25,000r and 30,000r units in *capsularis*. The plants were observed periodically from their early stages of growth. Morphological variations were, in general, similar to those noted during the previous year. It was also observed that there was a general increase in the number of variations in the materials treated with increased dosages but no definite correlation could be established between the number of variations produced and dosages applied.

Variations observed in materials treated with lower dosages were of a superficial nature affecting mostly the leaves while those treated with higher dosages showed variations in the stem and the reproductive organs besides variations in leaves.

429 *capsularis* and *olitorius* selections were made in the different treatments for further studies. These included a number of promising selections which were set apart for yield tests.

Vegetative rapprochement as a means of overcoming interspecific cross incompatibility in jute.—Seeds from both stock and scion, carried forward from a successful third generation graft of the previous year, were sown. All the 16 fourth generation grafts attempted employing cleft, inarch and splice methods of grafting were successful. Seeds obtained from both the stocks and scions of 11 grafts were carried forward and the rest failed to produce any seed.

36 interspecific crosses between grafts of the two species were attempted resulting in a number of normal-sized capsules. But none of them yielded any viable seed.

3. Inheritance of Character

Genetic strains.—In all 92 selections carried forward from the true breeding strains of the previous year were grown.

The progenies of all the cultures were studied and their respective parental characters such as pigmentation pattern, branching habit, leaf shape and size including the shape of the leaf margin, taste of the leaf, whether bitter or non-bitter, stipule character, colour of the corolla and shape of the petals, anther colour, maturity, size and shape of the pod, seed-coat colour, etc. were confirmed. 495 selections covering all the different strains were made for further studies.

64 selections brought forward from the purification series of the previous year were also grown. The performance of the progenies of the different cultures with respect to various characters on the basis of which they were selected, was studied. In all 142 selections were carried forward from the materials for further studies and confirmation.

Isolation of full-green genotypes.—51 test crosses made during the previous year were sown along with 18 selections of parents for confirmation of the full-green genotypes. The progenies were studied and selections from the confirmed full-green parents were carried forward for inclusion in genetic strains. Six full-green genotypes, reported earlier, were carried forward.

28 routine test crosses covering all the six full-green genotypes so far isolated were carried forward along with their parents for study during the next year. Six fresh crosses made for isolation of some of the remaining genotypes were also grown. Four F_1 progenies covering the combinations were carried forward.

Capsularis leaf variants—Deeply serrated, female sterile type.—Seeds of 23 normal selections brought forward from the heterozygous families of the previous year were sown and the progenies studied. 18 of the families segregated into normal and variant progenies. Progenies of all the segregating families were classified at intervals of a fortnight. It may be mentioned in this connection that the variant which is female sterile can be carried forward only through crosses or through heterozygous normal plants from segregating families.

Crumpled leaf type.—Seeds of crumpled leaf mutant isolated from one of the C39-212 plots of the previous year were grown. The progenies bred true for the crumpled leaf character. To study the mode of inheritance of this character, crosses were made with the normal leaf types. 11 successful crosses and their parents were carried forward for further studies.

Inheritance of leaf shape and size in C. capsularis.—13 crosses covering combinations of broad, normal and narrow leaf types in jute obtained last year were grown along with their parents. The length and breadth of the lamina of the leaves of F_1 progenies, and their parents were recorded. The leaves of the F_1 progenies of crosses between broad and narrow leaf types were almost narrow; those of crosses between broad and normal leaf types were normal while those of crosses between normal and narrow leaf types were intermediate.

38 successful back crosses, F_1 progenies and their parents were carried forward for studies next year.

Seed-coat colour in C. olitorius.—24 back crosses, 24 F_1 selections of the previous year and their parents were grown during the year. The back crosses and F_2 families were studied and the progenies were classified into different seed-coat colour groups.

A number of promising F_2 progenies showing high vigour and good performance as regards height and base diameter were carried forward for inclusion in progeny trials.

Inheritance of plant height.—Crosses made previous year to study the inheritance of plant height in jute were grown along with their parents. The F_1 progenies were intermediate in height between the tall and dwarf parents. 25 successful back crosses with both parents along with selections of parents were carried forward.

Eight fresh crosses between the improved *olitorius* strains and the wild forms of *olitorius* were obtained. Crosses and parents were carried forward for studies next year.

Inheritance of earliness in C. capsularis.—Crosses between Maniksari, an early type and D154, a late type, made previous year were grown along with their parents. The F_1 s were intermediate in maturity. 12 successful back crosses, F_1 progenies and parents were carried forward for studies during the next year.

64 fresh crosses covering combinations of early, medium and late types were obtained. All the crosses and their parents were carried forward.

II. ANATOMY OF JUTE

1. Developmental anatomy of axillary buds

It has already been reported that in *C. capsularis* (Variety D154) buds develop from the meristems isolated in the axils of leaves from the apical meristem during growth and vacuolation. The mode of development of buds in *C. trilocularis*, *C. fascicularis* and *C. acutangulus* is similar to that in D154. In *C. olitorius* and *C. siliquosus*, their development is somewhat different. The detached meristems soon after vacuolation occupy regions slightly above the axil proper. Hence the buds in initial stages of development are cauline in origin in these two cases. The branches ultimately occupy axillary position during subsequent growth adjustments.

2. Structure and quality of fibre in Jute

The fibre cells in transverse section of the stem show four to six layers when they are treated with swelling reagents. When the retted fibre strands are sectioned chemically and stained with Congo red, each layer shows two to six subsidiary layers. There is a decrease in the number of layers in each main layer with the decrease of activity of the plant.

When the fibres are treated with iodine and sulphuric acid and squashed, four to six layers alternating in direction with each other in lateral view are observed. These layers

correspond with the principal layers seen in the transverse section. The principal layers are prominent due to alternation of direction and possibly due to the presence of non-cellulosic constituents like lignin, while the subsidiary layers in each principal layer are less distinct and more difficult to discern because of the similarity in direction and the degree of orientation.

Typical balloons were not observed previously in jute and this was explained to be due to the weakness of the primary wall. When the delignified fibres were treated with sulphuric acid, typical balloons developed. The constricting power of the primary wall has been explained to be due to the presence of lignin, etc. When the lignin is removed, the primary wall is actually weakened. It, therefore, seems that balloon formation is not due to the constricting power alone; the internal structure of the fibre, the orientation and alternation of the secondary wall layers appear to play a prominent role in balloon formation. When the inner layers swell, the swelling is not uniform and where there is less swelling, the primary wall fibrils slip over there and accentuate the constriction. Unequal swelling of the secondary wall layers precedes the slip-over of the primary wall fibrils. This unequal swelling is due to the alternation of direction of the layers. Due to the spiral orientation and lateral expansion resulting from swelling, any fibril swells in opposite directions at two points along the length of the fibre. Because of this difference in orientation, the inner layers swell differently and increase the effect caused by the next outer layer thereby imparting constricting power to it. This causes a sort of loose knot-like constriction which is capable of shifting or untwisting. This alternation of layers seems to be partly responsible for sections obtained chemically by Kelaney and Searle.

In very greatly swollen fibres, even at a total magnification of 4000, no crystallites of the size mentioned by Farr and her associates could be detected and when they are taken to the point of dissolution, crystals did not emerge out and they retained fibrillar character.

3. Study of formation of fibre layers in relation to plant height and base diameter

This study was taken up to find out the relationship between the number of fibre bundles in cross section and the fibre content of the plant. Five *capsularis* varieties were taken up for study and four plants were taken from each variety in two stages of development. After taking a small piece from the bottom region, the plants were retted and the fibre was extracted. The total number of fibre bundles were calculated as described in last year's Annual Report and the results are given in Tables IV and V. In the early stage the total number of fibre bundles showed corresponding relationship to the total fibre content of the plant. In the later stage, however, such a relationship could not be established.

TABLE IV

Total number of fibre bundles in relation to fibre content in prebud stage

Variety	Number of the plant	N	R	N × R	Weight of the fibre
1. Fanduk	1	320	5.86	1875	1.59 gms.
	2	309	4.78	1477	
	3	294	4.64	1264	
	4	330	5.45	1798	
	Mean	313.25	5.18	1628	
2. D154	1	301	5.34	1607	1.58 gms.
	2	298	4.91	1463	
	3	301	5.18	1559	
	4	297	5.42	1609	
	Mean	299.25	5.21	1559	
3. Hal-mahera	1	318	4.69	1491	1.51 gms.
	2	293	5.26	1541	
	3	306	5.35	1636	
	4	289	5.09	1470	
	Mean	301.50	5.10	1534	
4. Jap Red	1	312	4.63	1444	1.49 gms.
	2	290	4.84	1423	
	3	304	4.82	1465	
	4	302	4.80	1449	
	Mean	302.00	4.77	1445	
5. C39-212	1	289	4.03	1164	1.43 gms.
	2	284	5.15	1462	
	3	283	4.58	1296	
	4	295	4.24	1150	
	Mean	287.75	4.50	1268	

N = Total number of fibre bundles near the cambium.

R = Ratio of total number in a single fibre wedge to N.

N × R = Total number in a section.

TABLE V

*Total number of fibre bundles in relation to fibre content
in bud stage*

Variety	Number of the plant	N	R	N x R	Weight of the fibre.
1. Fanduk	1	770	6.41	4935	12.17 gms.
	2	784	6.47	5072	
	3	800	6.78	5424	
	4	768	5.77	4431	
	Mean	755.5	6.34	4972	
2. D154	1	816	5.96	4863	12.44 gms.
	2	758	6.01	4555	
	3	720	6.46	4651	
	4	703	6.00	4248	
	Mean	748.0	6.11	4570	
3. Halmahera	1	749	6.04	4523	12.74 gms.
	2	720	6.21	4471	
	3	728	6.05	4404	
	4	723	6.51	4706	
	Mean	730.0	6.20	4526	
4. Jap Red	1	745	5.87	4373	11.07 gms.
	2	736	5.66	4165	
	3	744	6.41	4769	
	4	755	6.07	4582	
	Mean	745.0	6.00	4470	
5. C39-212	1	734	6.14	4506	11.23 gms.
	2	703	6.09	4281	
	3	727	6.22	4521	
	4	712	5.81	4136	
	Mean	719.0	6.06	4336	

N = Total number of fibre bundles near the cambium.

R = Ratio of the total number in a single fibre wedge to N.

N x R = Total number in a section.

4. Miscellaneous

Fibre samples were received from the Department of Commerce and Industries, West Bengal, Chief Controller of Imports and Exports, Government of India and some other government and private organisations. Necessary informations were sent after examination of the fibres.

III. CYTOGENETICAL INVESTIGATIONS

1. Interspecific hybridization

The importance of combining the desirable characters of *C. capsularis* and *C. olitorius* has been long recognised. Over 1,000 interspecific crosses were attempted at Dacca during the period 1939-43. A number of crosses made using the ordinary method of making straight crosses resulted in failure. Other methods like application of stigma paste of the male parent on the stigma of the female parent, reducing the length of the style in *olitorius* mothers by pruning, mixed pollen methods were all tried without success. The results were no better even when the two species were crossed in the tetraploid state. Since the setting up of the Institute in Indian Union, every year a number of interspecific crosses have been attempted between the two species in the diploid and tetraploid states and their combinations.

During the year under report interspecific hybridization was again carried out between a large number of varieties including wild types to investigate the varietal differences in crossability. The capsules set were noticed in practically every cross. Percentage set of capsules and good seeds obtained from them varied greatly not only in the different varietal crosses of both the species but also in the reciprocal crosses. Most of the seeds obtained were empty. Hybridity of the well-set seeds would be confirmed in this growing season.

Study of factors involved in incompatibility between C. capsularis and C. olitorius in crosses.—It has been previously reported that the rate of growth of the pollen

tubes is the same in self—and cross-matings both in *C. olitorius* as ♀ and *C. capsularis* as ♀. Incompatibility is not due to any retardation in the growth of the pollen tubes along the styler tissues in either case. Further studies were undertaken to understand the behaviour of the pollen tubes of both the species in the styles and in the ovaries. Pistils were fixed at 5 mins., 15 mins., 30 mins., 1 hour, 1½ hours, 6 hours, 12 hours, 24 hours, 36 hours, 2 days, 3 days and 4 days after crossing. Materials have been embedded in paraffin.

2. Cytological studies

(i) *Cytological studies of Corchorus*.—Root tips of *C. acutangulus*, *C. olitorius* (wild), *C. capsularis* (wild) and five plants of $2n \times 4n$ *olitorius* were fixed in Craff solution, dehydrated and embedded in paraffin for cytological studies.

In the flower buds of *C. depressus*, *C. Christensen* (Syn. *C. antichorus*) fixed and sent by Professor N. K. Tiwary from Allahabad, divisional stages were not observed.

In *C. depressus* and *Corchorus* sp., obtained from Aden, seven bivalents* were regularly noticed at metaphase I. Thus the haploid chromosome number of each of these species is 7. The cytological analysis of p.m.c's of *C. olitorius* (wild), Kalichar, Deodhali, Halmahera and D154 $\times$ variant *n* showed that meiosis is normal; at metaphase I seven bivalents were regularly observed in them.

(ii) *Cytological investigations of certain individuals of $2n \times 4n$ population of C. olitorius (Var. C.G.)*.—The results obtained so far indicate that the somatic chromosome number varies from 20 to 23. Most common meiotic pairing noticed is I IV + 3 III + 2 II + 4 I; 2 IV + 1 III + 5 II; 2 IV + 4 II + 5 I; and 2 IV + 1 III + 2 II + 6 I. The quadri-valents are commonly noticed in the form of rings and chains. As many as three rings of four were noticed in a single plate. The chromosome distribution at both the divisions of meiosis is very irregular. The complete cytological analysis is under progress.

3. Colchicine treatment and X-irradiation of jute

(i) *Colchicine treatment on wild types of C. capsularis and C. olitorius*.—The seeds of wild types of *C. olitorius* and *C. capsularis* were treated with concentrated H_2SO_4 in glass tubes for an hour and then washed with distilled water till free of acid. Two seeds were planted at each place at a distance of 2" $\times$ 2" in wooden boxes. Large number of seedlings were treated with 0.25 per cent and 0.1 per cent aqueous solution of colchicine by hanging drop method in the cotyledonary stage. The treatment consisted of keeping the drops of colchicine solution hanging in permanent contact with the growing point. This was accomplished by treating the seedlings earlier before the cotyledonary leaves expanded. Immediately after the treatment, each seedling was covered by a glass vial in order to keep high humidity around it and thereby to maintain more or less the same concentration of the solution throughout the treatment and to avoid any movement of seedlings due to wind. The duration of treatment was for 6, 12, 24, 36 and 48 hours.

0.25 per cent aqueous solution of colchicine was found to be drastic in the treatment of the seeds as well as seedlings of these wild species. Because of this, the whole treatment was repeated with 0.1 per cent colchicine solution.

The seedlings which were affected by colchicine showed various symptoms, such as, distorted cotyledonary leaves, thickening of the stem tip and retardation of growth. Unfortunately most of the affected seedlings died because of the severe attack of various pests including collar rot caused by the fungus *Macrophomina phaseoli*. Necessary control measures were taken and the surviving seedlings were transplanted in 10 inches pots.

Seed treatment with 0.25 per cent and 0.1 per cent was also followed. Most of the seedlings, however, died. Acetocarmine analysis of pollen grains of the surviving plants indicated more than 70 per cent sterility and much variation in the size of pollen grains in three of the *olitorius* plants. The seeds of the surviving plants have been sown this year.

It can be concluded that the seedling treatments by the hanging drop method, though more laborious, seem to be better than the seed treatments, mainly because in the previous one the seedlings to be treated have already been established and the effect is only on the shoot apices so that the chances of the seedlings to survive from the poisonous effect of the drug is greater. This is so since only one growing organ is affected.

(ii) *Induction of mutations by the use of X-irradiated pollens.*—The flower buds that were to bloom in the morning were gathered some two hours earlier in cellophane bags and were irradiated at about 9 A.M. with 200 K.V.P., constant potential, H.V., 1.75 mm., Cu. filter. The dosages employed were 50, 100, 200, 400 and 500 r units. The flower buds to be pollinated were emasculated in the previous evening. The irradiated pollen was used for pollinating flowers of the same variety. The plants used in this experiment were grown in pots and their flowers were pollinated under the shed so as to facilitate pollination and save the crosses from heavy wind and rain prevailing at the flowering period.

The results of these studies are summarised in Table VI.

TABLE VI

Strain	Dosage in r units.	No. of flowers pollinated.	Number of capsules set.	Seeds				Per cent of full seeds
				Empty	Partly full	Full	Total	
C39-212 (<i>C. capsularis</i>)	50	25	17	22	82	384	488	78.69
	100	25	13	31	14	227	272	83.46
	200	25	9	9	28	226	263	85.93
	400	25	13	257	11	116	384	30.21
	500	25	18	83	45	490	618	79.29
O40-632 (<i>C. olitorius</i>)	50	25	5	133	94	492	719	68.43
	100	25	9	182	...	1307	1489	87.78
	200	25	9	113	...	779	892	87.33
	400	25	7	466	...	92	558	16.49
	500	25	6	191	...	243	434	55.99

It may be seen from the table above that the number of capsules set and the number of different kinds of seeds (empty, partly full and full) obtained in each case has no relationship with the dosages in both *C. capsularis* and *C. olitorius*. The seeds gathered in each case have been sown during this year for further study.

(iii) *Cytological studies of X-ray induced mutations in jute (Corchorus)*.—Cytological investigations of the X-irradiated plants were undertaken. The plant studied herein resulted from X-irradiation (with hard rays) of dry seeds of *C. capsularis* (C39-212) with 40,000 r units. This grew normally for 1½ months and then the stem bifurcated into two branches—one being normal with round stem and big leaves, and the other with much flattened stem and small roundish leaves. The flattened branch flowered earlier than the normal one. The normal round branch was much larger than the flat one indicating that the cells with chromosome aberrations multiplied slowly. The flower buds for meiotic studies were fixed in acetic-alcohol (1 : 3) and stored in 70 per cent alcohol. Temporary smears with acetocarmine were made.

In the untreated materials, usually seven bivalents are found at diakinesis and metaphase I, while in this mutant different degrees of pairing such as 7 II, 7 II + 1 to 4 fragments, 6 II + 2 fragments, 1 IV + 5 II and 2 IV + 3 II were observed. Usually one bivalent, occasionally two bivalents were found attached to the nucleolus. The fragments observed at diakinesis and subsequent stages are the result of failure of union of broken chromosomes. Quadrivalent formation is possibly due to the occurrence of reciprocal translocation in the non-homologous chromosomes. The presence of two quadrivalents indicates that it is likely that four non-homologous chromosomes are involved in translocation.

Occasionally one to two chromosomes were found on the spindle away from the metaphase plate. They are unpaired chromosomes and behave as univalents. Thus, they seem to be unable to pair with their original non-homologous chromosomes because of severe changes in their constitution.

Both at the first and the second meiotic divisions various irregularities were observed. The high degree of chromosome aberration was confirmed by examination of tetrads. Of the large number of tetrads (1273) analysed, 57 per cent were apparently normal looking but the size of microspores varied greatly within them. The remaining were found as diads (1.1%), triads (5.3%), pentads (20.8%), hexads (12.2%), septads (2.0%), octads (0.6%) and nonads (0.1%). The diads presumably resulted from the lack of spindle formation at either metaphase I or II. The triads are due to failure of one of the divisions of metaphase II. Occurrence of pentads to nonads has direct relationship with the number of acentric fragments and eliminated chromosomes in the cytoplasm, due either to their lack of pairing at metaphase I or failure of movement to either poles.

Considerable sterility in pollen grains was noted. Only 4 per cent of the pollen were stained (viable) and the rest of them, either normal-looking or shrivelled, were not stained. Twenty five stained pollen grains were measured at random. The diameter of them varied from 225 to 425 μ .

The high frequency of chromosome aberrations such as reciprocal translocations, fragments, univalent formations, lagging, elimination of chromosomes and failure of spindle formation in certain p.m.c's found in this irradiated plant suggests that the restitution of chromosome unbalance which occurred as a result of X-irradiation with 40,000 r units is poor.

Cytological analysis of the plant with bifurcation resulting from the X-irradiation of dry seeds of *C. olitorius* (O40-632) with 30,000 r units (hard rays) shows different degrees of pairing 7 II + 0 to 1 fragment, 5 II + 1 IV + 0 to 3 fragments and 3 II + 2 IV + 0 to 3 fragments. One or two quadri-valents observed in certain p.m.c's were found attached to the nucleolus.

In addition to normal bivalent formation, irregularities like failure of separation in one or two of the chromosome pairs was also recorded. At anaphase I, one to two chromosome

bridges accompanied by fragments were observed. At telophase I, a bridge, either intact connecting both the telophasic nuclei or in a broken condition, was observed and as many as three fragments were noticed.

Out of 1292 tetrads analysed, 273 were triads, 1017 normal tetrads and 2 pentads. The tetrad analysis indicates that the fragments commonly observed in the different stages of meiosis get lost in the cytoplasm.

4. Pollen grain studies

Pollen grain studies in a new type (round leaf) of *C. capsularis* whose cytological irregularities were previously reported were undertaken. Out of 717 pollen grains analysed, 666 (92.9%) were found to be fertile. These showed considerable variation in size. Pollen grain studies were also made in 59 different plants including *capsularis* and *olitorius* tetraploids and their crosses with diploids, colchicine treated plants, X-rayed plants, chlorotic plants and a few wild types.

Studies on pollen grain morphology.—In the last Annual Report, results of studies on the different wild species of *Corchorus* and some of the cultivated and wild forms of *C. capsularis* and *C. olitorius* were reported. During the year under report, further studies were made on the pollen grains of a number of varieties of *C. capsularis* and *C. olitorius* and *C. tridens* from Portugal. 200 grains were measured in each case. They were found to be mostly oblate and tricolpate as reported previously.

It seems from the comparative biometric measurements that *C. fascicularis* is not closely related to the rest of the species. In *C. tridens* (Portugal) and some types of *C. capsularis* the variations noticed in pollen grain size may be due to environmental factors. Though *C. siliquosus* is a natural polyploid ($n = 14$), it has pollen grains practically of the same size as those of other diploid species.

Pollen tube cytology of C. olitorius and C. capsularis in vitro.—Pollen tubes were grown in culture media from both the species. The examination of the permanent slides of

pollen tubes of *C. capsularis* shows that the pollen tubes contain the generative cell and not the generative nucleus alone as reported earlier.

Examination of pollen tubes of these two species reveals that sperm formation takes place by cytokinesis of the generative cell. In prometaphase stages, chromosomes are scattered throughout the nucleus; sometimes they are grouped together at one side or two sides in an irregular manner. Sperms are definite cells of different sizes at first. Later they contract and become smaller and spindle-shaped. Each sperm contains definitely a nucleus with surrounding cytoplasm.

In *C. olitorius* three sperms in a tube were noted in a single instance.

IV. PHYSIOLOGICAL INVESTIGATION

1. Investigations on the physiology of jute seeds

(i) *Viability efficiency of seeds collected at different stages of maturity from green capsules, half-matured capsules and fully matured capsules.*—The results obtained in seeds

collected in 1952 from Fanduk, D154, C.G. and O40-632 have been tabulated in Table VII.

TABLE VII
Percentage of germination of seeds from green, half-matured and fully matured capsules.
 Date of sowing 9-6-53

Nature of capsules.	Period of germination (Hrs)	Fanduk	D154	C. G.	O40-632
Green ... {	24	...	16.4	29.2	11.7
	48	...	33.6	11.8	10.8
	72	...	19.0	3.5	3.2
	Total germination.		69.0	44.5	25.7
Half-matured. {	24	85.5	53.3	70.9	57.7
	48	7.0	31.1	10.2	15.7
	72	0.3	5.6	1.0	2.6
	Total germination.	92.8	94.0	82.1	76.0
Fully matured {	24	91.0	71.2	80.4	70.5
	48	2.3	19.7	3.5	9.0
	72	0.0	2.4	1.8	3.2
	Total germination.	93.3	93.3	85.7	82.7

This year's result confirmed the results obtained during last two years, indicating that both in green and half-matured capsules, the seeds were well-set and fully formed. The seeds from green capsules showed lower percentage of germination

than those from half-matured ones. Seeds from fully matured capsules showed maximum percentage of germination. It has been indicated that good seeds may be collected by harvesting half-matured capsules and the plants need not be kept in the field for seed purposes upto dry-pod-stage of the plants. The importance of this has already been stressed that good quality fibre and also seed can be obtained from the same plant, by proper selection of the harvest time.

(ii) *Investigations on the 'Dual purpose' of harvesting jute.*—Actual field experiments were conducted to test the practical application of 'dual purpose' of harvesting. In order to find out the best time of harvest when both, good quality seed as well as good quality fibre could be obtained, three harvests were made coinciding with the three stages of the capsules (which could be visually identified) as (1) fully-developed but green, (2) capsules the colour of which was turning brown and (3) fully-matured dark brown capsules. These stages of capsules more or less corresponded with 126 days, 134 days and 142 days of growth of the plant from the date of sowing. In order to get comparable results, all the varieties used here, viz., *Capsularis*—D154, and Fanduk, *Olitorius*—C.G. and O40-632, were harvested at the same time, though in actual practice their dates of harvest should be different

according to the earliness or lateness of the crop. The preliminary results have been tabulated in Table VIII.

TABLE VIII.

*Production of fibre and seeds in dual purpose
of harvesting jute.*

Varieties	Harvests	Green wt. per acre in maunds.		Fibre wt. per acre in maunds		Quality Ratio	Yield of seeds per acre in maunds from top portion.	Percentage of germination.
		Whole plant	Top removed.	Whole plant	Top removed.			
Fanduk	II	247.24	173.42	10.22	9.92	104±2.0	6.27	92.80
	III	201.89	135.42	8.75	7.81	108±1.6	6.20	93.30
D 154	I	351.51	225.66	14.26	13.25	89±1.5	4.19	69.00
	II	259.25	150.25	12.02	10.68	110±0.9	5.41	94.00
	III	228.85	167.59	12.53	11.53	103±1.5	5.63	93.00
C. G.	I	347.17	272.21	15.84	15.19	100±1.8	1.21	25.70
	II	306.00	277.38	13.38	12.82	96±1.5	3.32	82.10
	III	255.72	196.48	11.69	11.18	87±1.3	4.77	85.70
O40-632	I	323.33	269.04	17.01	16.42	91±1.3	0.60	25.70
	II	286.94	248.49	17.35	17.05	96±1.0	1.79	76.00
	III	245.31	234.04	15.87	15.45	107±2.3	3.27	82.70

I—Harvest at 126 days.
II— „ „ 134 days.
III— „ „ 142 days.

The harvested plants were divided into two sets. In one, the tops (about 6" below the point of bifurcation) were removed for seed collection, and the rest of the plant was retted for fibre. In the other, the whole plant was retted for fibre. A comparison of the fibre yields from the two sets shown in Table above indicates the possibility of obtaining good quantity of seeds as well as good quality fibre from the same harvest. By removing the top portion only a small portion of the yield in fibre is affected. The quality ratio was shown to be best

on the average in the second stage in *capsularis* varieties, where seed production was also fairly high. In the *olitorius* variety C.G., the quality ratio was high in 1st stage of harvest, while O40-632 showed high quality ratio in the third stage, which confirmed the previous findings that in O40-632 the rate of fibre formation was more in later stages than the rate of formation in C.G. The germination capacity of the seeds collected at different stages showed normal percentage of germination in second and third stages. The experiment would be continued on a larger scale.

(iii) *Performance of jute seeds collected from plants grown in off-season in winter.*—Results obtained with D154 and C.G. have already been reported last year. This year, in addition, seeds of two Jute Agricultural Research Institute improved strains, *capsularis* C39-212 and *olitorius* O40-632 were sown in 3 instalments in November, December and January. The germination percentage was good but the plants as in previous year, showed very slow and stunted growth and attained a height of 9 to 12 inches only, though they developed many branches. The number of capsules was less but they were well developed and contained normal and good seeds showing high percentage of germination. The seeds thus collected will be sown during the next jute season to see the performance during normal season.

2.—Nature and range of flowering and seed formation in different varieties of jute

(i) *Nature of flowering.*—Investigations on this have been in progress for the last three years. On the basis of results obtained a comprehensive review of the nature of flowering is presented here. Important varieties of *capsularis*,—D154, Fanduk, Jap Red, C42-Kj-321, and C39-212 and of *olitorius* —C.G. R26, O39-620, O40-632 and O40-753, were studied under identical field conditions. They were sown on the same date and daily rate of flower opening was recorded throughout the flowering period beginning from the first flower opening in each of the varieties. For the sake of comparison weekly averages were calculated. The results indicated the

same trend in the two species as has already been reported. Though the date of first flower opening differed in different varieties, yet the trend of the flowering curve with optimum and minimum variations, showed specific differences in *capsularis* and *olitorius* species. All the varieties within the species behaved similarly as regards the flush and rate of flowering. The results are tabulated in Table IX.

TABLE IX

Rate of flowering during the different weeks of flowering range

—	Varieties	First flower from date of sowing in days	FLOWERING RANGE									
			1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	9th week	10th week
<i>Capsularis</i>	D154	112	4.7	7.2	9.2	5.3	3.9	1.3	0.5	0.2	0.5	0.2
	Jap Red	115	2.5	4.0	5.0	3.2	2.3	1.0	0.4	0.3	0.2	0.2
	Fanduk	96	1.5	2.9	4.2	7.3	8.8	3.8	1.9	0.3		
	C42-Kj.321	110	3.6	9.9	13.1	7.8	2.5	0.9	0.3	0.1		
	C39-212	116	1.0	1.8	5.1	8.1	6.1	4.4	2.1	1.0	1.3	1.7
<i>Olitorius</i>	C.G.	122	2.1	3.7	5.7	4.0	5.4	5.6	2.5	3.1	1.2	0.5
	R26	126	0.2	1.6	3.9	3.0	3.5	2.4	1.9	1.8	0.6	
	O39-620	123	0.4	1.6	2.6	3.2	4.1	1.6	3.3	3.6	2.2	0.9
	O40-753	130	0.3	2.1	1.8	2.0	2.4	1.7	1.1	0.7	0.3	
	O40-632	130	0.6	2.5	2.0	2.2	2.0	0.9	0.4			

(ii) *Number of seeds formed in capsules developed at different times of flowering period and their viability efficiency.*—The investigations were repeated with the capsules collected during the different stages of the flowering period in five *capsularis* varieties—D154, Fanduk, Jap Red, C41-Kj-321 and C39-212, and five *olitorius* varieties—C.G., R26, O39-620, O40-632, and O40-753. The capsules were arranged according to their ages, developing from the flowers opened at different times of the flowering period. The average number of seeds per capsule in *capsularis* varied from 30 to 40,

and the maximum number of seeds were formed in those capsules which were formed during the optimum range of flowering period (112-125 days growth of the plant from sowing date) and in later stages the number of seed formed decreased. In *olitorius* the number of seeds varied from 130 to 200 and as there were periodic flushes of flowering spread over a wide range of flowering period, no definite period was located for optimum setting of seeds, thus differing from *capsularis*. But indication of optimum seed setting was found in the first half of the flowering range. The individual variations and other details would be further worked out.

Higher percentage of germination was noted in the seeds collected from capsules developed in the earlier weeks of flowering period, which decreased in later weeks in *capsularis* varieties. In *olitorius* varieties, a higher percentage of germination was indicated in the middle weeks which also decreased in later weeks.

3. Effect of vernalization and photoperiods on the initiation of the reproductive phase in jute

The experiments conducted last year were repeated with other varieties with long and short-day period and at the same time pre-sowing temperature treatment (vernalization) was also carried out. The seeds were vernalized for 30 days at 8-10°C and sown along with untreated but soaked seeds in glazed earthen-ware pots. The short day experiments as in the previous year were conducted under field conditions and long-day treatments (16 hours light period obtained by supplementing with artificial illumination after sunset) were conducted in glazed earthen pots. Pre-sowing cold treatment alone was found to be effective in *capsularis* varieties in inducing earliness of flowering, while in *olitorius* varieties a tendency towards lateness was observed. Of the different photoperiods, the long-day treatment (16 hours) delayed the initiation of flowering stage in all the jute varieties, while in the short-day treatments (8 hours or 10 hours) marked earliness was found as reported in the last Annual Report. The post-sowing photostage (either short-day or long-day) determined the initiation of reproductive phase, irrespective of pre-sowing cold treatment. The

photoperiod was more effective and brought about a significant earliness or delaying effect (in relation to short or long-day treatment) when given in the early stages of the plant growth, showing that the effective photo-stage was located in jute in the early stage of growth.

TABLE X

Effect of long-light period on the induction of flowering in jute

Date of sowing—16-6-53

(Days of flowering from sowing date)

Variety		Treated-16 hrs. Light-period + 8 hrs. dark period	Non-treated, control 12 hrs. light + 12 hrs. dark period	Lateness due to long light period
D154	...	89	78	11
Jap Red	...	93	86	7
Chinsurah Green	...	89	74	15
O39-620	...	98	87	11

4. Experiments on Salt Resistance in jute

The work on salt resistance was planned to conduct investigations under laboratory conditions as well as under field conditions in certain saline regions of West Bengal. The field part of the investigation at Kakdwip, a saline region of West Bengal could not be conducted as the fields selected were flooded, but the laboratory experiments along with field experiments at the Institute farm were carried out. The following experiments were conducted—(1) Inducing resistance by pre-sowing treatment with different salt concentrations and growing the treated seeds in different salt concentrations. (2) Inducing resistance in seedlings by growing them in critical salt concentration and collecting seeds for further experiments. (3) Growing seedlings in off-season in winter in different salt concentrations and collecting seeds to carry out further experiments. (4) Growing as many varieties as possible in small repli-

cated plots in the field, and treating the plants at different ages with different salt concentrations. The following results were obtained during the year under report.

The seeds were soaked in 1% and 1.5% NaCl solution for 12, 24, 48, and 72 hours. Slightly germinated soaked seeds were sown against control seeds which were soaked only in water. The seedlings thus raised were further grown in different salt concentrations, the concentration of which was maintained by periodic flushing with the solution. The results indicated a slight increase in salt tolerance in treated seedlings as compared to untreated controls. The jute seedlings tolerate a concentration from 1 to 1.5 per cent NaCl and the seedlings were grown in 1.5 to 2.0% concentration (taken as critical concentrations). The seeds from surviving plants were collected and will be treated in the same manner for increasing the tolerance. The field experiment could not be continued to the entire satisfaction due to drought in the early stages and heavy showers in the later stages when the different concentrations of NaCl were applied.

5. Root-system in jute species

Root-growth study was continued with Jap Red, C39-212 (*capsularis*), O40-632 and O40-753 (*olitorius*), in addition to the varieties previously studied. The roots were washed at different stages—32 days and 100 days of growth from sowing date. The specific differences in the length, mode of spreading, volume and growth of secondary root as noted earlier were confirmed.

6. Variation in growth and pattern of unit structures contributing towards the yield of fibre

Preliminary results on the growth and variations in such structures as phloem-pyramids, distribution of fibre bundles in the pyramids and the formation of layers of fibre bundles per pyramid during the life cycle of the plants, were reported last year for D154 and Jap Red, a branching and a non-branching type of *capsularis*, and C.G. and O39-620, two

olitorius varieties. Further analysis of results on C.G. and O39-620 are given in the Table XI.

TABLE XI
*Variations in growth and pattern of unit structures
 contributing towards the yield of fibre
 (Date of sowing)--28-4-52
 Chinsura green*

Days from sowing	50	65	79	93	107	121	135	163
	Vegetative stage			Flowering stage			Pod stage.	
Total number of phloem pyramids ...	30	36	39	40	46	50	52	60
Average No. of fibre bundles per pyramid	32.1	47.6	53.1	61.7	73.9	83.8	100.4	112.1
Average No. of layers of fibre bundles per pyramid ...	9.0	9.4	9.8	11.8	12.8	13.0	14.2	14.4
Plant height (in.) ...	55.0	72.0	91.0	106.0	120.0	127.0	129.0	130.0
Base diameter (cm) ...	1.3	1.6	1.8	1.9	2.0	2.0	2.1	2.1

O39-620

	Vegetative stage				Flowering stage		Pod stage	
Total number of phloem pyramids ...	28	35	43	48	50	52	54	60
Average No. of fibre bundles per pyramid	29.8	33.1	49.3	93.0	100.5	112.4	151.8	165.0
Average No. of layers of fibre bundles per pyramid ...	8.6	8.6	12.6	15.4	15.4	15.4	16.4	18.0
Plant height (in.) ...	56.0	78.0	101.0	117.0	127.0	144.0	148.0	151.0
Base diameter (cm) ...	1.3	1.5	1.7	1.8	1.9	1.9	1.9	1.9

The observations were made from the basal region of 0.6" of the main stem by taking series of transverse sections with sledge microtome. The first observation was made at 50 days

growth when the average number of layers of fibre bundles per pyramid was found to be 9.0 in C.G. and 8.6 in O39-620. The increase in the number of layers was gradual upto 79 days growth, after which a rapid increase in the layering was noticed in both the varieties upto 121 days growth. Later, the rate decreased in C.G. but in O39-620 the rate was maintained for a longer period of growth. The variation in the formation of number of fibre bundles per pyramid also showed the same trend. When the growth of individual pyramids was considered, it was found that the number of pyramids was the same (60 in each) in both the varieties at 163 days growth. This may be accidental but considering the variation in different stages of growth it may be concluded that higher yield in O39-620 was more due to the increased number of layers resulting in greater number of fibre bundles per pyramid.

7. Investigations on growth in different species and varieties of Jute with reference to moisture content, bark and fibre growth and wood formation during the life-cycle of the plant

The work has been in progress for the last four years and comprehensive results on many important aspects of growth with regard to different growth components have been collected bringing into prominence the specific and varietal nature of growth process. Almost all the important varieties of both *capsularis* and *olitorius* species have been covered and correlations of different growth components have been worked out. The results obtained during the year under report are represented under different heads as follows :

(i) *Variation in growth of pure fibre at different heights of the stem and at different stages of the plant growth.*—Pure fibre was estimated by chemical retting as was done in previous years. The stem was sampled into 6" portions from the base. The results on the varieties D154, Jap Red (*capsularis*) and C.G., O39-620 (*olitorius*) have been discussed here. The growth of pure fibre was more in the basal regions of the stems than in the upper regions of the growing stem. The sequence of fibre formation was found to be the same in all the stages

of growth, beginning from the early stages to the late pod-ripening stage, during the four years of study. The rate of growth was more in the transition stage from the vegetative to the reproductive phase and later the growth significantly slowed down. The variations of growth components in the different varieties observed at different stages of growth of the plant showed the interdependence of fibre formation and flowering behaviour, which were found to be different in the two species. In *capsularis* varieties the flowering range was found to be limited to a narrow period with a peak of maximum flowering and the growth components also behaved more or less similarly. But in *olitorius* varieties a long range of flowering period with periodic flushes was found, and the formation of the growth components also varied and the growth activity was maintained over a wider range.

(ii) *Distribution of pure fibre in bottom, middle and top regions of the stem.*—Further work on the specific differences in the growth and distribution of pure fibre in D154, Jap Red, C.G. and O39-620 in three important zones, bottom, middle and top, has been carried out and the results are shown in Table XII.

Percentage distribution of pure fibre was calculated on the total weight of pure fibre of the stem at different stages of plant growth. The results on some of the varieties have been previously reported and the distribution was found to be of the same order. More fibre was found in the bottom portion in *capsularis* varieties than in the *olitorius* varieties. In the middle and top portions of the stem, *olitorius* showed higher percentage of fibre than *capsularis*. With progressive apical growth and lengthening of the stem the fibre distribution became more even in *olitorius* varieties than in *capsularis* varieties. Different varieties in the same species showed different values for distribution of fibre in the bottom, middle and top portions of the stem. The same was the mode of distribution of total dry matter, bark and wood.

TABLE XII

Percentage distribution of pure fibre along the stem calculated on the total pure fibre of the stem at different stages of the plant growth.

Date of sowing—28.4.53.

D154 (Capsularis)

Days from sowing	50	65	79	93	107	115	121	163
Bottom	62.81	61.54	61.70	56.87	57.88	57.35	54.21	50.32
Middle	29.08	30.77	29.52	29.71	29.94	29.88	30.25	33.05
Top	8.11	7.69	8.78	13.42	12.18	12.77	15.54	16.03

Jap Red (Capsularis).

Days from sowing	50	65	79	93	107	115	121	163
Bottom	59.89	58.69	57.14	53.30	54.94	55.79	57.76	48.70
Middle	31.58	31.11	31.06	30.63	31.30	31.50	32.08	33.33
Top	8.55	10.00	11.80	16.07	13.76	12.71	16.16	17.97

Chinsurah Green (Olitorius)

Days from sowing	50	65	79	93	107	115	121	163
Bottom	66.67	62.35	58.55	51.10	50.54	49.49	47.86	44.28
Middle	27.26	29.63	29.64	32.64	36.17	35.43	36.60	35.70
Top	6.07	8.02	11.81	16.25	15.29	15.08	15.54	20.02

O39-620 (Olitorius)

Days from sowing	50	65	79	93	107	115	121	163
Bottom	65.79	64.81	56.55	57.55	47.78	48.74	47.97	43.40
Middle	30.26	29.01	29.47	33.04	34.42	35.31	35.28	35.25
Top	3.95	6.17	14.02	9.41	17.71	15.95	16.76	21.35

(iii) *Percentage variations in the distribution of pure fibre.*—The results on the distribution of pure fibre in relation to (a) total green weight, (b) total dry weight, (c) total bark weight and (d) total wood weight in C.G. and O39-620 have been given in Table XIII.

TABLE XIII
Development of different growth-components at different stages of life-cycle of the plant
(all weights are in gms.)
Date of sowing—28-4-53
Chinsurah Green

Days from sowing.	50	65	79	93	107	121	135	163
Total length of the stem ...	24"	48"	72"	96"	120"	138"	144"	150"
Total green wt. ...	20.38	39.14	82.21	157.76	185.41	227.93	319.99	472.50
Total bark wt. ...	1.77	3.30	7.03	12.90	19.97	26.05	32.56	46.02
Total wood wt. ...	2.24	3.82	9.81	20.41	30.94	43.99	57.92	87.34
Total pure fibre wt. ...	0.62	1.62	4.15	7.26	10.59	14.87	19.37	26.67
Total dry weight (bark and wood) ...	4.01	7.12	16.84	33.31	50.91	70.04	90.48	133.36
Percentage of pure fibre in terms of green weight ...	3.04	4.14	5.05	4.60	5.71	6.52	6.05	5.64
Percentage of pure fibre in terms of dry weight ...	15.46	22.75	24.64	21.80	20.80	21.23	21.41	20.00
Percentage of pure fibre in terms of bark weight ...	35.03	49.09	59.03	56.28	53.03	57.08	59.49	57.95
Percentage of pure fibre in terms of wood weight ...	27.68	42.41	42.30	35.57	34.23	33.80	33.44	30.54

O39-620

Days from sowing	50	65	79	93	107	121	135	163
Total length of stem ...	30"	48"	72"	102"	114"	132"	144"	153"
Total green weight ...	24.52	40.63	89.79	175.84	177.79	217.53	354.71	518.99
Total bark weight ...	2.23	3.55	8.13	15.71	20.21	27.49	39.09	56.64
Total wood weight ...	2.56	3.91	10.22	21.11	28.55	40.86	62.32	91.32
Total pure fibre wt. ...	0.76	1.62	4.92	9.14	11.07	15.49	22.62	31.66
Total dry weight (bark and wood) ...	4.79	7.46	18.35	36.82	48.76	68.35	101.41	147.96
Percentage of pure fibre in terms of green weight ...	3.10	3.98	5.48	5.26	6.23	7.13	6.38	6.10
Percentage of pure fibre in terms of dry weight ...	15.87	21.72	26.81	24.82	22.70	22.66	22.31	21.40
Percentage of pure fibre in terms of bark weight ...	34.08	45.63	60.52	58.18	54.77	56.35	57.87	55.83
Percentage of pure fibre in terms of wood weight ...	29.69	41.43	48.14	43.30	38.77	37.91	36.30	34.67

During the early stages of growth different lengths of the stem were available for sampling according to the growth of the varieties. The distribution of pure fibre was therefore calculated on total length of stem which varied at different stages of growth when samples for study were taken. In the above Table the improved strain of O39-620 has been compared with C.G. The percentage of pure fibre in terms of green weight and dry weight showed higher values in case of O39-620 than in C.G. These variations became more marked during the flowering period beginning from about 93 days of growth. In the early stages the variations were not so prominent. These results confirmed the growth behaviour of O39-620 as described earlier, viz., the accelerated growth in later stages of the life-cycle of this plant than in C.G.

(iv) *Ratio of bark formation to that of wood formation.*—

More results were obtained on the formation of crude bark in relation to wood formation in C.G. and O39-620. The results clearly show a higher ratio value in O39-620 than in C.G., which was in accordance with the behaviour of the growth components, as already noticed and discussed in previous years.

(v) *Growth sequence in relation to stalk and foliage.*—

This aspect of study was begun last year to investigate the vigour, growth of main stem and corresponding output of leaves during the life-cycle of the plant. D154 and C.G. were taken as standard *capsularis* and *olitorius* varieties. Firstly, the weight of the stalks together with attached leaves was taken and secondly, all the leaves were removed and the stripped weight of the stalks was taken to give the weight of the green leaves at different stages of growth, viz., 45 days, 66 days, 88 days and 108 days. The samples were taken from 6 replicated plots with an average of 18 plants from each replication.

The results show that in early stage of vegetative growth (45 days) in *capsularis* (D154), the proportion of stem and leaf weights was 71.5% and 28.5%. This increased to about 74.5% in case of stem and the leaf weight decreased to 25.5% at 66

days growth. The leaf weight gradually decreased to 16.4% at 108 days growth. While in *olitorius* (C.G.) almost the same sequence of growth of stalk in relation to output of leaves was obtained in the early stages, in the later stage, leaves accounted for only 11% of the total weight. The above results showed that there was a greater leaf fall in *olitorius* variety than in *capsularis* variety.

8. Comparative studies on the physiology of growth of fibre in branching (D154) and non-branching (Jap Red) varieties of capsularis jute

Some of the results obtained on this aspect of study have been reported last year. The results indicated more or less similar variations in pure fibre formation, as well as in wood and bark formation during the different stages of growth in both branching and non-branching varieties. Further results have been obtained on the distribution of pure fibre in relation to (1) green weight, (2) dry weight, (3) bark weight, and (4) wood weight, which have been represented in Table XIV.

The percentage distribution of pure fibre in terms of different components indicated no marked differences which could be traced back to the branching or non-branching habit of the two varieties. The trend of variations are similar in both the varieties with individual differences at certain phases of growth. Varietal differences were more marked when distribution of growth components was considered along the growing stem from base to apex than in the progressive stages of growth of the plant.

TABLE XIV

Development of different growth components at different stages of growth in branching and non-branching capsularis varieties

(All weights in gms.)

Date of sowing—28-4-53

D154 (Branching)

Days from sowing	50	65	79	93	107	121	135
Total length of stem	30"	48"	66"	90"	102"	108"	114"
Total green weight	17.71	37.68	71.01	128.72	133.32	164.34	205.43
Total bark weight	1.72	3.03	6.14	11.40	15.33	20.46	24.81
Total wood weight	2.13	3.08	6.86	12.69	18.03	25.57	33.03
Total pure fibre weight	0.72	1.43	3.76	6.26	8.55	11.96	14.48
Total dry weight (bark and wood)	3.85	6.11	13.00	24.09	33.36	46.03	57.88
Percentage of pure fibre in terms of green weight	4.07	3.80	5.30	4.86	6.41	7.29	7.05
Percentage of pure fibre in terms of dry weight	18.70	23.40	28.92	25.99	25.63	26.03	25.02
Percentage of pure fibre in terms of bark wt.	41.86	47.19	61.24	54.91	55.77	58.55	58.36
Percentage of pure fibre in terms of wood wt.	33.80	46.43	54.81	57.21	47.42	46.85	43.79

Jap Red (Non-branching)

Days from sowing	50	65	79	93	107	121	135
Total length of stem	30"	48"	72"	96"	114	126"	132"
Total green weight	23.55	42.73	75.39	128.03	151.58	195.75	265.47
Total bark weight	1.99	3.12	5.51	10.72	15.31	22.39	27.99
Total wood weight	2.49	3.44	6.80	13.15	20.69	29.96	42.90
Total pure fibre weight	0.90	1.52	3.22	5.91	9.01	13.30	17.08
Total dry weight (bark and wood)	4.48	6.56	12.31	23.87	36.00	52.35	70.89
Percentage of pure fibre in terms of green weight	3.82	3.56	4.27	4.62	5.94	6.79	6.43
Percentage of pure fibre in terms of dry weight	20.09	23.17	26.16	24.76	25.03	25.41	24.09
Percentage of pure fibre in terms of bark weight	45.23	48.72	58.44	55.13	58.85	59.40	61.02
Percentage of pure fibre in terms of wood weight	36.14	44.19	47.35	44.94	43.55	44.39	39.81

V. JUTE AGRONOMY

1. Variety-*cum* spacing-*cum* manurial Trial on Jute

To study the effect of various spacings and manuring on early and late jute varieties, two trials, one with *capsularis* and another with *olitorius* jute, were conducted. The various spacings tried were, light thinning $\times 12''$, $2'' \times 12''$, $3'' \times 12''$ in rows sown with drill one foot apart as against usual broadcast sowing. Two varieties, one early (Fanduk) and the other late (D154) were included in the case of *capsularis* trial, and C.G. (early) and O40-632 (late) in the case of *olitorius* trial. Manures applied were at two levels, 0 lb. N and 40 lb. N per acre, both from organic and inorganic sources at equal N basis. Organic manures were town compost and F.Y.M. at equal nitrogen level, calculated at 50 per cent. N availability basis. A long drought which continued for 3 weeks shortly after sowing affected the young crops adversely, resulting in drying up of young seedlings. The plant population in both the trials fell short of the requisite number, particularly, in the *olitorius* trial which was therefore abandoned. The data on green weight and fibre weight are given in Table XV. From the results, it will be seen that the fibre obtained from the line plots is more than that from broad-cast plots. The effect of manuring tended to be more pronounced with early variety Fanduk than with the late one D154. The combined treatment effect was significant at 1 per cent level. Effect of spacing and manuring was also significant. D154 (late variety) with manure and with the spacing $3'' \times 12''$ gave the highest yield—24.58 maunds per acre as against 19.19 maunds (D154) and 16.62 maunds (Fanduk) per acre as control.

TABLE XV

*Trial on Variety-cum Spacing-cum Manuring**C. capsularis* (Fanduk and D154)

Layout—Replicated randomized layout in 4 replications.

Effective plot size—48' × 14' or 0.0154 acre.

Sown on—29-4-53. Harvested on— { Fanduk—21-8-53.
D154—14-9-53.

Treatments	Green weight per acre in maunds	Fibre weight per acre in maunds	Percentage on control
A. $S_0 V_1 M_0$	319.17	16.62	100.00
B. $S_0 V_1 M_1$	423.71	20.50	123.35
C. $S_1 V_1 M_0$	388.53	20.58	123.83
D. $S_1 V_1 M_1$	439.12	21.36	128.52
E. $S_2 V_1 M_0$	395.84	20.25	121.84
F. $S_2 V_1 M_1$	469.76	22.73	136.76
G. $S_3 V_1 M_0$	411.65	21.03	126.53
H. $S_3 V_1 M_1$	452.96	22.27	134.00
I. $S_0 V_2 M_0$	400.00	19.19	100.00
J. $S_0 V_2 M_1$	464.42	21.29	110.94
K. $S_1 V_2 M_0$	473.71	21.72	113.18
L. $S_1 V_2 M_1$	465.61	21.71	113.13
M. $S_2 V_2 M_0$	421.34	21.01	109.48
N. $S_2 V_2 M_1$	483.00	22.42	116.83
O. $S_3 V_2 M_0$	419.36	21.24	110.68
P. $S_3 V_2 M_1$	541.30	24.58	128.09

 V_1 —Fanduk. V_2 —D154. S_0 —Broad-cast sowing. S_1 —Light thinning × 12"—Drill sowing in lines. S_2 —2" × 12"—Drill sowing in lines. S_3 —3" × 12"— " " " " M_0 —No manure. M_1 —40 lb. N per acre.

2. Manurial Trials

(a) *Effects of nitrogen, phosphorus and potash.*—To study the effect on yield and quality of fibre with varying doses of nitrogen, phosphorus and potash and their combinations, two trials, one with *capsularis* and another with *olitorius* were carried out.

The treatments included three levels of nitrogen (0 lb., 20 lb. and 40 lb. N per acre), two levels of phosphorus (0 lb. and 40 lb. $P_2 O_5$ per acre), two levels of potash (0 lb. and 25 lb. $K_2 O$ per acre) and combinations thereof in both the trials.

The data on yield, per cent. yield on control and cost of manures are given in Tables XVI and XVII. The application of N was significant in increasing the yield of fibre in both *capsularis* and *olitorius* jute, though there was no statistical difference between 20 lb. N and 40 lb. N applications. The increase over the control (No manure) in case of *capsularis* trial was 29.28 to 59.68 per cent. and in *olitorius* trial 17.97 to 32.25 per cent. Effect of phosphorus or potash either singly or in combination was not found significant, so far as the yield of fibre was concerned.

TABLE XVI

Manurial Trial—C. capsularis (D154)

Layout—Replicated randomized blocks in 4 replications.

Effective plot size—32' $\times$ 18' or 0.0132 acre.

Sown on—5-6-53. Harvested on—8-10-53 to 9-10-53.

Treatments	Fibre yield per acre in maunds	Per cent on control	Cost of fertilizers in Rs.	Extra yield due to fertilizer application in maunds
A. $N_0 P_0 K_0$ (Control)	14.31	100.00	—	—
B. $N_0 P_0 K_1$	14.97	104.61	7.59	0.66
C. $N_0 P_1 K_0$	14.32	100.07	29.72	0.01
D. $N_0 P_1 K_1$	21.10	147.45	37.31	6.79
E. $N_1 P_0 K_0$	21.33	149.06	16.06	7.02
F. $N_1 P_0 K_1$	19.19	134.10	23.65	4.86
G. $N_1 P_1 K_0$	20.32	142.00	45.78	6.01
H. $N_1 P_1 K_1$	18.50	129.28	53.37	4.19
I. $N_2 P_0 K_0$	21.44	149.83	32.12	7.13
J. $N_2 P_0 K_1$	22.85	159.68	39.71	8.54
K. $N_2 P_1 K_0$	21.63	151.15	61.84	7.32
L. $N_2 P_1 K_1$	19.67	137.46	69.43	5.36

P ... 0.01.

S. E. % ... 7.37.

C. D. ... 5.45 maunds per acre.

TABLE XVII

Manurial Trial—C. olitorius (O40-632)

Layout Replicated randomized blocks in 4 replications.

Effective plot size—18' × 32' or 0.0132 acre.

Sown on 5-6-53. Harvested on—12-10-53.

Treatments	Fibre yield per acre in maunds	Per cent. on control	Cost of fertilizers in Rs.	Extra yield due to fer- tilizer appli- cation in maunds
A. N ₀ P ₀ K ₀ (Control)	19.42	100.00	—	—
B. N ₀ P ₀ K ₁	20.42	112.21	7.59	1.25
C. N ₀ P ₁ K ₀	20.00	108.58	29.72	0.58
D. N ₀ P ₁ K ₁	17.78	96.53	37.31	—
E. N ₁ P ₀ K ₀	22.97	124.70	16.06	3.55
F. N ₁ P ₀ K ₁	21.73	117.97	23.65	2.31
G. N ₁ P ₁ K ₀	22.38	121.50	45.78	2.96
H. N ₁ P ₁ K ₁	22.73	123.40	53.37	2.96
I. N ₂ P ₀ K ₀	23.69	127.60	32.12	4.27
J. N ₂ P ₀ K ₁	24.29	131.87	39.71	4.87
K. N ₂ P ₁ K ₀	25.63	139.14	61.84	6.21
L. N ₂ P ₁ K ₁	25.65	139.25	69.43	6.23
P	...	...	0.05.	
S. E. %	...	...	7.65.	
C. D.	...	...	4.86 maunds per acre.	

(b) *Effect of organic and inorganic nitrogen.*—To study the effect of various proportions of organic and inorganic sources of nitrogen on yield and quality of jute two trials, one with *capsularis* and another with *olitorius*, were carried out. For inorganic source ammonium sulphate at 100 per cent availability basis and for organic source a mixture

(giving equal quantities of nitrogen) of town compost (0.85 per cent. total nitrogen) and sludge (0.76 per cent. total nitrogen) at 50 per cent. availability basis were used. The treatments included application of 30 lb. available N per acre from both organic and inorganic sources at various proportions (100, 67, 50, 33 and 0 per cent). No manure, as control, was also included. The data on fibre yield and per cent yield on control for *capsularis* trial are given in Table XVIII.

Here also the long drought affected the young seedlings adversely, particularly, in the *olitorius* crop. Heavy attack of mite also played a part in unbalancing the manurial behaviour; the *olitorius* trial after a heavy shower (when manures got washed away from one plot to other) was rejected.

TABLE XVIII

Effect of organic and inorganic nitrogen at 30 lb. nitrogen level per acre—C. capsularis (D154)

Layout—Replicated randomized blocks in 4 replications.

Effective plot size—38' × 20' or 0.0175 acre.

Sown on—1-5-53. Harvested on—18-9-53.

Treatments	Fibre yield per acre in maunds	Per cent on control
A. No manure (Control) ...	23.65	100.00
B. 50% N from ammonium sulphate plus 50% N from organic manure	25.06	105.96
C. 33% N from ammonium sulphate plus 67% N from organic manure ...	24.44	103.34
D. 67% N from ammonium sulphate plus 33% N from organic manure ...	24.14	102.07
E. 100% N from ammonium sulphate plus 0% N from organic manure ...	26.17	110.66
F. 0% N from ammonium sulphate plus 100% N from organic manure ...	24.13	102.03

P ... 0.05

S. E.% ... 1.78

C. D. ... 1.6 md. per acre

From the results of the *capsularis* trial, it can be seen that higher proportions of inorganic sources tended to give higher yields. Nitrogen 100 per cent from inorganic source

was found to be significantly superior to nitrogen 100 per cent from organic sources.

(c) *Application of fertilizers in instalments.*—To find out the effect of time of application of ammonium sulphate on the yield of jute, two trials, one with *capsularis* and another with *olitorius*, were carried out. The treatments included the application of 30 lb. N per acre from ammonium sulphate at various stages of crop growth (*i.e.* before sowing, at first weeding and at second weeding). The data on fibre yield and per cent yield on control are given in the Table XIX for *capsularis*.

TABLE XIX.

Effect of time of application of ammonium sulphate
C. capsularis (C39-212)

Layout—Replicated randomized blocks in 4 replications.

Effective plot size—16' × 28' or 0.0103 acre.

Sown on—5-5-53. Harvested on—21-9-53.

Treatments			Fibre yield per acre in maunds	Per cent on control
A.	No. manure (Control)	...	25.21	100.00
B.	30 lb. N per acre before sowing	...	27.94	110.83
C.	10 lb. N per acre before sowing plus 20 lb. N per acre at 1st weeding	...	26.54	105.28
D.	10 lb. N per acre before sowing plus 10 lb. N per acre at 1st weeding plus 10 lb. N per acre at 2nd weeding	...	23.99	95.16
E.	0 lb. N per acre before sowing plus 30 lb. N per acre at 1st weeding plus 0 lb. N per acre at 2nd weeding	...	23.96	95.04
F.	0 lb. N per acre before sowing plus 0 lb. N per acre at 1st weeding plus 30 lb. N per acre at 2nd weeding	...	27.78	110.19
G.	10 lb. N per acre before sowing plus 0 lb. N per acre at 1st weeding plus 20 lb. N per acre at 2nd weeding	...	28.74	114.00
H.	0 lb. N per acre before sowing plus 20 lb. N per acre at 1st weeding plus 10 lb. N per acre at 2nd weeding	...	28.05	111.27
P			0.05	
S. E. %			4.00	
C. D.			3.51	

The treatment differences in *capsularis* trial were significant. Application of ammonium sulphate, 1/3rd quantity at the time of sowing and the remaining 2/3rd at second weeding, gave the highest yield.

In the *olitorius* trial the application of ammonium sulphate at any stage of crop growth either in one application or in instalments was not found significant.

(d) *Comparative merits of nitrogenous fertilizers and manures (both organic and inorganic)*—To study the effect of comparative merits of various nitrogenous fertilizers and organic manures on the yield and quality of jute, two trials, one with *capsularis* and another with *olitorius*, were conducted with a manurial dose of 30 lb. of available nitrogen per acre. Organic manures were applied at 50 per cent. N availability basis.

The data on yield per acre and per cent. yield on control have been shown in Table XX for *C. capsularis*. Chilean nitrate and ammonium sulphate proved significantly superior to sludge, F.Y.M. or control in the *capsularis* trial. Chilean nitrate alone is significantly superior to ammonium sulphate nitrate but not to other fertilizers in the same *capsularis* trial. There were no treatment differences in the *olitorius* trial.

TABLE XX

Comparative merits of various nitrogenous fertilizers and manures (both inorganic and organic).

C. capsularis (C39-212)

Layout—Replicated randomized blocks in 4 replications.

Effective plot size—48' × 14' or 0.0154 acre.

Sown on —10.5.53.

Harvested on—22.9.53.

Treatments		Fibre yield per acre in maunds	Per cent. on control
A.	Chilean nitrate	29.18	119.64
B.	Ammonium sulphate	28.52	116.93
C.	Sodium nitrate	28.14	115.38
D.	Urea	28.07	115.09
E.	Paul's mixture	27.92	114.47
F.	Potassium nitrate	27.42	112.42
G.	Compost	26.76	109.72
H.	Talukdar's mixture	25.35	103.94
I.	Ammonium sulphate nitrate	24.61	100.90
J.	Sludge	23.17	95.00
K.	F.Y.M.	21.85	89.59
L.	Control (No manure)	24.39	100.00
P		0.05	
S.E. %		5.39	
C.D.		4.07 md. per acre.	

3. Manurial Trials in States

To ascertain the manurial behaviour on jute under varying soil and climatic conditions, simple trials under cultivators' field conditions were conducted for the third consecutive year in the various jute growing States of West Bengal, Bihar, Assam, Orissa, and U.P.

The trials were conducted in both acid and non-acid zones. The treatments of each are shown below :

A. For non-acid zone

1. No manure—Control.
2. 20 lb. N per acre from ammonium sulphate.
3. 40 lb. N per acre from ammonium sulphate.

B. *For acid zone*

1. No manure—Control.
2. 20 lb. N per acre from ammonium sulphate.
3. 3 md. lime alone per acre.
4. 6 md. lime alone per acre.
5. 3 md. lime and 20 lb. N per acre.
6. 6 md. lime and 20 lb. N per acre.

Table below gives a list of trials conducted during the year under report.

States	Number of trials scheduled			No. of trials successfully conducted			Total number of trials failed or not conducted.
	Acid zone	Non-acid zone	Total	Acid zone	Non-acid zone	Total	
1. Bihar	34	50	84	13+3*	38+5*	59	25
2. West Bengal	...	30	30	...	22	22	8
3. Assam	...	16	16	...	10	10	6
4. Orissa	...	12	12	...	10	10	2
5. U. P.	...	6	6	...	2	2	4
Total	34	114	148	16	87	103	45

*Special trials—(3 in acid areas and 5 in non-acid areas)

Bihar.—The effect of nitrogen both at 20 lb. and 40 lb. level was positive like previous years. In the non-acid zone, the average increase recorded was 45.9 per cent and 77.1 per cent over 'No manure' (control) plots with application of 20 lb. N and 40 lb. N per acre respectively.

In the acid zone higher dose of lime application (6 maunds per acre) followed by top dressing with 20 lb. N per acre increased the fibre yield considerably. Lime alone also either at 3 maunds per acre or 6 maunds per acre increased the fibre yield though the difference between them was negligible.

West Bengal.—All the trials were conducted in the non-acid zone. As in previous years the N application gave posi-

tive responses, the increase being 20.7 per cent and 36.5 per cent for 20 lb. N and 40 lb. N per acre respectively.

Assam.—All the trials were conducted in non-acid soils. Nitrogen application was found beneficial for Assam soils. The increase recorded was 23.6 per cent for 20 lb. N and 40.6 per cent for 40 lb. N application.

Orissa.—Response to nitrogen application was more pronounced than in West Bengal. The yield increased by 28.3 per cent and 53.2 per cent over control by application of 20 lb. N and 40 lb. N per acre respectively.

U.P.—Out of 6 trials conducted, 4 failed due to various reasons. In the two successful trials nitrogen gave higher yields than 'no manure'.

The results from all the jute growing States were analysed and the effect of N from ammonium sulphate was assessed. Nitrogen was found to increase the yield of fibre in all the jute growing States. The extent of increase from application of ammonium sulphate varied from State to State.

4. Triple Cropping Experiment

(a) *At Nilganj, Barrackpore.*—To study the possibilities of triple cropping mid-lands with *capsularis* jute followed by paddy and then khesari (pulse) as third crop, one trial was conducted during the year. As no suitable and sufficient land was available at Jute Agricultural Research Institute farm for such trials a site in a cultivator's field adjacent to the farm was selected.

The treatments included two varieties of jute, one early (Fanduk) and other late (D154), for the first crop with two stages of harvest (early and late harvests *i.e.*, 90 days and 120 days crop age respectively) followed by transplanted *aman* paddy (Patnai). Manuring jute (first crop) or paddy (second crop) either in one instalment or in two equal instalments as against unmanured jute alone, unmanured paddy alone and unmanured jute and paddy was also included. The results confirm our previous findings on crop yield, advantage of

double and triple cropping over growing paddy alone. The data on the duration of the crops, yield, cost of cultivation, value of produce and profit are given in Table XXI.

Jute gave higher fibre yields with later stages of harvest. For the same period of crop growth late variety (D154) gave slightly higher yields than the early variety (Fanduk).

In case of paddy earlier transplantings gave higher yields than late transplantings. Growing of jute as an earlier additional crop has not been found to lower the yield of paddy in the same land appreciably provided paddy is transplanted by first part of August. Jute and paddy both gave positive responses to manurial treatments. Khesari as a third crop failed due to lack of moisture. The experiment as such can be treated as a double cropping experiment.

Double cropping jute lands (mid-lands) with capsularis jute followed by paddy

Layout—Replicated randomized blocks in 4 replications.

Effective plot size—15' x 39' or 0.0134 acre.

Sown on - 4.5.53.

Sl. No.	1st crop jute variety.	Duration of 1st crop jute to sowing date.	Duration of 2nd crop paddy to harvest date.	Manuring with nitrogen and organic sources (lb. per acre)	Yield per acre in md.			Gross value of produce per acre in * Rs.	Cost of cultivation for produce per acre in Rs.	Net profit per acre in Rs.
					Jute fibre 1st crop	2nd crop	Paddy straw			
1	Fanduk (early)	4.5.53 to 2.8.53	4.8.53 to 4.12.53	25 lb. N to jute only.	10.26	23.61	34.73	497.43	385.67	111.76
2	Fanduk (early)	4.5.53 to 2.8.53	4.8.53 to 4.12.53	25 lb. N to jute + 25 lb. N to paddy	9.80	23.84	37.00	491.22	406.65	84.57
3	D154 (late)	4.5.53 to 2.8.53	4.8.53 to 4.12.53	25 lb. N to jute only.	11.44	20.20	31.33	494.60	384.80	109.80
4	D154 (late)	4.5.53 to 2.8.53	4.8.53 to 4.12.53	25 lb. N to jute + 25 lb. N to paddy	10.84	22.70	33.82	503.33	409.33	94.00
5	Fanduk (early)	4.5.53 to 2.8.53	4.8.53 to 4.12.53	25 lb. N to jute only.	16.85	14.53	24.29	573.93	419.09	154.84
6	Fanduk (early)	1.9.53 to 4.5.53	5.9.53 to 4.12.53	25 lb. N to jute + 25 lb. N to paddy	15.28	12.49	28.38	524.49	428.17	96.32
7	D154 (late)	1.9.53 to 4.5.53	5.9.53 to 4.12.53	25 lb. N to jute only.	18.02	12.03	20.66	577.73	420.14	157.59
8	D154 (late)	1.9.53 to 4.5.53	5.9.53 to 4.12.53	25 lb. N to jute + 25 lb. N to paddy	18.25	13.62	27.69	606.71	444.97	161.74
9	D154 (late) alone	1.9.53 to 4.5.53	5.9.53 to 4.12.53	25 lb. N to jute.	22.09	—	—	552.25	342.06	210.19
10	D154 (late) alone	1.10.53	—	50 lb. N to jute.	23.34	—	—	583.50	355.68	227.82
11	—	—	28.7.53 to 25.11.53	25 lb. N to paddy	—	30.65	51.08	321.82	188.34	133.48
12	—	—	28.7.53 to 25.11.53	50 lb. N to paddy	—	30.87	51.30	323.91	210.79	113.12
13	D154 (late)	4.5.53 to 1.10.53	—	No manure.	14.99	—	—	374.75	263.96	110.79
14	D154 (late)	4.5.53 to 1.9.53	5.9.53 to 4.12.53	No manure.	12.93	13.39	21.57	462.73	369.94	92.79
15	—	—	28.7.53 to 25.11.53	No manure.	—	25.65	40.23	265.55	154.76	110.79

* Jute—Valued at Rs. 25/- per md.

Paddy—Valued at Rs. 8/- per md.

Straw—Valued at Rs. 1/8- per md.

(b) *At Chinsurah Government Agricultural Farm.*—To study the possibilities of triple cropping midlands under Chinsurah conditions one experiment with *capsularis* jute followed by paddy and pulses was conducted. The treatments included two dates of jute harvests—early and late, for both Fanduk (early variety) and D154 (late variety) followed by paddy as second crop and khesari (pulse) as third crop after paddy. The treatments of jute alone and paddy alone were also included in the trial. The data confirm the previous years' findings. Paddy yield seemed to be unaffected by growing an additional earlier crop of jute in the same land provided paddy was transplanted within the optimum period. Higher profit was obtained by growing jute and paddy in the same land over the usual practice of growing paddy alone.

5. Date of Sowing Experiments with *C. capsularis* and *C. olitorius*

To study (a) the effect of different dates of sowing on yield and quality of jute and also (b) the behaviour of different varieties of jute when sown on different dates under Nilganj conditions, two trials were conducted, one with *capsularis* and the other with *olitorius* jute.

The treatments included six dates of sowing commencing from 16th March, at an interval of 20 days between sowings in both the trials. Two varieties, one early—Fanduk, and the other late—D154, in case of *capsularis*, and for *olitorius* one early—C.G. and the other late—O40-632, were included. Both early and late varieties were harvested at the same time after a fixed period. March sowings were done with irrigation in both *capsularis* and *olitorius*. As regards the yield of fibre, April sowings gave the best results in both *capsularis* and *olitorius*. Sowings of *capsularis* during the latter part of April gave significantly higher yields than those of the earlier part of April. For *olitorius*, though sowing in latter part of April gave the highest yield, sowing done in earlier part of the month proved equally good. Sowings done either earlier than April or later than April gave poorer yields in both *capsularis* and *olitorius*.

Late varieties of both *capsularis* and *olitorius* jute proved significantly superior to early varieties.

VI. SOIL, BIO-CHEMICAL AND MICRO-BIOLOGICAL STUDIES.

1. Quality of Fibre

The work on quality of fibre carried out during the period mainly consists of finding out other causes of colouration of the fibre besides iron and tannic acid, the influence of varieties and of soil conditions.

Colouration of fibre.—The cause of fibre colour has been ascribed to the presence of tannin in jute plants and of iron in retting water. Besides the concentration of tannic acid and iron, the pH of the retting water plays an important part in forming the colour of the fibre. Although it is not possible to control the quantity of iron and tannin which come from the soil and the plants steeped, the pH can be controlled to some extent. In a laboratory scale experiment, pH was controlled at different values between 4.4 to 8.4 by use of buffer solutions. It has been found tentatively that colouration is comparatively more in water having higher pH values and at very low pH values.

Laboratory tests showed that the colour of *shamla* coloured fibres obtained from the market and prepared artificially in the laboratory may be removed by treatment with solution of oxalic acid, phosphoric acid, hydrochloric acid, citric acid and tartaric acid. Samples of fibre before final wash, were dipped in 1% and 2% hydrochloric acid, 1% and 2% citric acid, and 1% and 2% tamarind extract for different periods of time ranging from one to two seconds to 30 minutes, after which they were washed in tap water. It has been found that a treatment for a period of 5 minutes is sufficient to remove the *shamla* colour with 2% tamarind extract, 2% citric acid or 2% hydrochloric acid. Although the cost involved in the process has not been worked out, it may be stated tentatively that 2% tamarind extract may

prove economic in removing the *shamla* colour. Large scale experiment will be carried out in the next season and arrangement will be made for testing the fibres technologically.

Varietal factors.—Work has been in progress with different varieties for studying their tannin absorption capacities at different concentrations and at different pH values. The varieties taken are *olitorius*—O40-632, O39-620, R-26, C.G. and *capsularis*—D154, Fanduk, C41-13, JR48-1 and CT917.

Edaphic factors.—Green jute stems obtained from Chinsurah (West Bengal), Bansdih (Assam), Gograghat and Muzaffurnagar (U.P.) have been retted and fibre extracted under Barrackpore conditions to study the effect of soil factors on the quality of jute. The analysis of the soils from these places have been completed. The fibres have been sent for technological tests and the results are awaited.

It has been possible to take up this work due to the transfer of the scheme on the Biochemical retting of jute from the Science College to this Institute.

2. Retting of Jute

(A) *Action of different activators on retting of jute:*

(a) *Effect of synthetic and natural activators on retting:*

(i) *Effect of bone dust and ammonium sulphate.*—In the past few years, it has been found that a combination of ammonium sulphate and bone dust both added at the rate of 2 gms. per litre of retting water reduces the retting period considerably. The work during the period under report was carried out with a view to study the residual effect, the effect of volume of water in relation to the steeped material and also the time required for retting. Ammonium sulphate and bone dust both were added at the rate of 2 gms. per litre of retting water. In retting vats having a capacity of 56 litres of water, 1000 gms., 2000 gms. and 4000 gms. of green jute stems in case of *capsularis* and 1000 gms., 2000 gms. and 2800 gms. of green jute stems in case of *olitorius* were steeped. In previous years the effect of the activators was found to be more

pronounced during the later part of the season when the temperature is comparatively lower. The work was, therefore, carried out from middle of September to end of November. In case of *capsularis*, it was found that in all the three treatments, in the ammonium sulphate-bone dust treated vats, retting period was less than 50% of those in the vats where these activators were not added. In case of *olitorius* where the quantity of green stems steeped was 1000 gms., retting period in the vats receiving activators was little more than 50% of those vats receiving no activators. In such cases where 2000 gms. of green stems were steeped, there was no difference in the retting period and where 2800 gms. of green stems were steeped, retting was not completed even in 35 days in both treated and untreated vats. Residual effect has been observed in all the *capsularis* charges and in 1000 gms. *olitorius* charge. At 1000 gms. charge, the residual effect is more in *olitorius* and amongst *capsularis* charges the most was at 2000 gms. charge. With the controlled retting tank, which is expected to be constructed this year, this work will be carried out in more detail.

(ii) *Effect of trace elements.*—Effect of different forms of boron, molybdenum, zinc, selenium, cobalt, manganese, magnesium and copper at different dilutions in reducing the retting period was tried. It has tentatively been found that at a concentration of 100 p.p.m. with respect to the retting water, none of the forms of these micro-activators was effective. Molybdenum (as ammonium molybdate), zinc (both as zinc sulphate and zinc chloride), selenium (as sodium selenate), cobalt (as cobalt nitrate) and copper (as copper sulphate) at a concentration of 100 p.p.m. was rather toxic for micro-organisms responsible for retting and there was no retting even in 35 days. In some cases, a concentration of 10 p.p.m. and in some other cases, a concentration of 1 p.p.m. of these activators reduced the retting period. Further work will be taken up to study the possibility for their use either alone or in combination amongst themselves or with macro-

activators like ammonium sulphate and bone dust and fixing up the concentration of these micro-activators.

(iii) *Effect of micro-organisms in reducing the retting period.*—In the laboratory, the mixed cultures carried over from last year from a material from Gograhat has shown encouraging results but due to difficulties of laboratory space, no detailed work could be carried out.

(b) *Survey of retting water.*—42 samples of retting water were obtained from Gograhat (U.P.), Kopati (Assam), Tarakeswar, Barrackpore and Baraset (W. Bengal) areas to study their chemical constituents as well as the micro-organisms. In all 35 samples were studied and two cultures which show some tentatively better retting properties are being maintained. pH., dissolved oxygen, dissolved inorganic phosphorus, phenolphthalein alkalinity, methyl orange acidity, nitrate-nitrogen, ammoniacal-nitrogen and dissolved iron were determined in 37 samples. No conclusion can be drawn at this stage.

(c) *Retting without steeping.*—The possibility of retting without steeping was further investigated and it was found that if fully anaerobic conditions are created, there is practically no retting, but with partial anaerobic conditions, there was retting. The work will be continued.

(d) *Biochemical changes during retting.*—As the retting is slower in the later part of the season, the experiment was carried out in the later part of the season (end of September to end of October) with three varieties of jute, viz., D154 and C39-212 (*capsularis*) and C.G. (*olitorius*). pH, phenolphthalein alkalinity, dissolved inorganic phosphorus, dissolved oxygen, ammoniacal-nitrogen, nitrate-nitrogen, number of aerobic and anaerobic bacteria were determined periodically and qualitative determination of dissolved iron was also made in the retting water.

Although there are some differences, many of the biochemical changes are similar in all the three varieties. The common features are given below:

- (i) Number of aerobic bacteria and the amount of dissolved oxygen change in the reverse way.
- (ii) The number of aerobic bacteria sharply falls when the retting is completed and again rises when the number of anaerobic bacteria begins to fall.
- (iii) pH first rises and then falls; thereafter there are some irregular rises and falls and in the last stage there is a slight rise and it remains more or less constant at that value.
- (iv) The amount of nitrate-nitrogen after a first rise steeply falls followed by a slight rise and slight fall, and then there is a steep rise at the end.
- (v) The amount of ammoniacal-nitrogen first slightly falls; thereafter there are rises and falls and at the end there is a steep rise.

So far the change of the amount of dissolved inorganic phosphate and the number of aerobic bacteria, number of anaerobic bacteria and changes in phenolphthalein alkalinity are concerned there are some varietal and specific differences.

(e) *Isolation and purification of micro-organisms.*—

Three cultures of previous years, which have been tentatively found to hasten retting, have been maintained for further studies. Of the 58 cultures isolated from retting water during the season, two have been found to possess retting properties.

Decomposing fruits of *Guazuma tomentosa* under laboratory conditions have been found to hasten retting. Of the two fungi obtained from these fruits one has been identified to be a strain of *Aspergillus niger*. The cultures of these fungi as well as several cultures of *aspergillus* and *penicillium* are being maintained to extract extracellular and intracellular pectinases in order to study the catalytic effect of pectinases on retting.

3. Analysis of soils and manures for their chemical and mechanical constituents

(a) *Routine analysis.*—Routine analysis of 31 samples of manures, fertilizers, other materials and soils were done as and when required.

(b) *Soil survey.*—132 soils were obtained from Uttar Pradesh, Bihar and Orissa through the courtesy of the Directors of Agriculture of respective States and of extension plots of the J. A. R. I. pH (by Muirhead pH meter and by indicator method), organic carbon (by Walkley and Black method), exchangeable calcium (by Williams's method) and available phosphate (by seminormal acetic acid method) were done in 127 samples. It has been found that pH varies from 5.6-8.0, per cent organic carbon (Walkley & Black value) is usually of the order of 0.5 to 1.0 though there are a few cases when this value is more than 1.0 or less than 0.5. The amount of organic carbon in the plots of the extension centres of the Jute Agricultural Research Institute at Baraset, Basirhat and Barrackpore area are near about 1% and these soils are slightly acidic in nature. The soils from Bihar show wide variation and those from Orissa though showing wide variation are comparatively poor in their organic matter content. Some samples from Bihar are calcareous and many are comparatively rich in exchangeable calcium. The amount of available phosphorus in all the 127 samples show wide variation, but is comparatively higher than in soils where other crops are usually grown.

4. Soil exhaustion studies

(A) *Soil exhaustion studies in double-cropping plots.*—During the period under review samples were drawn plotwise before jute, after jute and after paddy as in last year and available nitrogen (nitrate-nitrogen and ammoniacal-nitrogen) were determined at all the three stages plotwise for 144 samples. The results have shown the same trend as reported last year, i.e. so far nitrogen-status (available) is concerned

the soils are in a better state of fertility if jute is harvested at earlier stages and if jute or jute and paddy be grown than when paddy is grown alone.

(B) *Soil exhaustion by different varieties of jute.*—The work, to test whether there was any differential exhaustion of the soil by different varieties of jute, was continued for the second year. Total nitrogen, available phosphorus (by Williams's and 0.15 normal sulphuric acid method), organic carbon (by Walkley and Black's method) and exchangeable calcium (by seminormal acetic acid method) were determined in 48 samples drawn plotwise from all the 24 plots before and after jute. It has been found that after two years' cropping, there are no marked differences in soil properties due to growing of different varieties of jute—*capsularis* (C39-212 and D154) and *olitorius* (O40-632 and C. G.). Total nitrogen and available phosphorus have generally increased, variation of organic carbon has been irregular, exchangeable calcium has increased in unmanured plots and decreased in manured plots.

(C) *Changes in nutrient status of soil:*—(a) *In heavily fertilized lands.*—(i) *With inorganic fertilizers.*—Ammonium sulphate and sodium nitrate affect the organic matter content of the soil, the pH and available phosphate considerably, both due to the microbiological and chemical processes taking place in the soil. In an experiment to find out the maximum production capacity of jute, 0 to 320 lb. of Nitrogen per acre (equal amounts of nitrogen from ammonium sulphate and sodium nitrate) were added. pH, organic matter, exchangeable calcium and available phosphorus were determined in 50 samples drawn from 25 plots before and after jute. After two years of manuring and cropping, it has been found that pH has fallen and organic carbon (oxidizable) has slightly increased and the fluctuation of available phosphorus and exchangeable calcium has been irregular.

In an experiment to find out the effect of ammonium sulphate on the yield and growth of jute and on the soil, an

experiment was laid out with 0 to 90 lb. of nitrogen as ammonium sulphate per acre. It is generally considered that application of ammonium sulphate considerably improverishes the soil so far as exchangeable calcium and organic matter are concerned. To examine this, organic matter and exchangeable calcium were determined plotwise in 30 samples drawn from 15 plots before and after jute. It has been found that after two years of manuring and cropping with jute, organic carbon has not changed much but in soils treated with higher doses of ammonium sulphate, there has been a fall in the exchangeable calcium content of the soils.

An experiment to find out the effect of superphosphate on the yield and growth of jute and on the soil due to growing of jute, was laid out with 0 to 28 lb. of phosphorus as superphosphate per acre. It is generally considered that application of superphosphate to Indian soils maintains the organic matter and exchangeable calcium status of the soils. Organic matter and exchangeable calcium were determined in 30 samples drawn from each of the 15 plots before and after jute. It has been found that after two years of cropping and addition of superphosphate, organic matter has not increased. It has rather decreased. This may possibly be due to comparatively less leaf fall in phosphate treated plots. Exchangeable calcium has rather slightly increased.

(ii) *With organic manures.*—An experiment to find out the effect of composts on the yield and growth of jute and on the soil due to growing of jute, was conducted with 0 to 260 mds. (containing 0 to 200 lb. of total nitrogen approximately) of compost per acre. Organic matter and exchangeable calcium were determined in 30 samples drawn from 15 plots before and after jute. It has been found that in compost treated plots, after two years of cropping and manuring, organic carbon has generally increased and there has been no change in exchangeable calcium.

(b) *Soil nitrogen*—(i) *Chemical.*—It was mentioned earlier that soil nitrogen is not either exhausted or to a very small

degree if at all by cropping with jute. 72 soils obtained from various experiments in which plot sizes were comparatively big to small were analysed for total nitrogen before and after jute. It has been found that after continuous cropping with jute, the total nitrogen content of the soil does not fall. It rather increases in a number of cases.

It has been previously stated that the fertility so far as total nitrogen is concerned is maintained by the falling leaves. A considerable number of plants are also thinned out during intercultural operations. This, excluding the quantity from which "*Bach Pat*" is obtained, may amount upto 50 mds. of green matter. These plants were allowed to rot at one corner of the field, as is usually done by the cultivators and after complete decomposition they were analysed for different forms of nitrogen. The jute compost thus obtained compares favourably with town compost and sludge so far as the total nitrogen is concerned. Composting caused a loss of weight of the green matter to the extent of 50% or more. It follows, therefore, that from an acre of land 8 to 25 maunds of compost of better manurial value than town compost and sludge may be obtained without any additional effort or cost. Work is in progress to produce better quality composts that retain the nitrogen, as there has been a loss of 75% of nitrogen under the present process of aerobic composting. It has been found that jute composts prepared aerobically are comparatively poor in easily soluble nitrogeous constituents because of leaching and oxidation.

(ii) *Microbiological*.—Sequence of change of different forms of nitrogen with soil micro-organisms under the influence of ammonium sulphate, compost and no manure in jute-cropped plots against no jute plots was studied. The variation is found to be more or less of the same type as reported last year.

(c) *Soil phosphorus*.—It has already been stated that not only available phosphorus but also other forms of phosphorus change with application of heavy doses fertilisers both

inorganic and organic. There has been a marked increase of alkali soluble phosphates in soils where jute was grown for two years continuously. Available phosphate by both (seminormal acetic acid and 0.15 normal sulphuric acid) methods increased more or less in all the plots. It has been found that, so far as phosphates are concerned, jute composts compare very favourably with sludge and town compost, and as sources of phosphates they are much better than any of the organic manures, if the quantity of easily soluble and alkali soluble organic phosphates that become ultimately available is taken into consideration.

(D) *Withdrawal of nutrients by the jute plant.*—(a) *accumulation of inorganic nutrient in the tip leaves (shoot apex).*—Inorganic calcium, phosphate, ammoniacal and nitrate nitrogen were estimated in the tip leaves (shoot apex) at different stages of growth. The concentration of nitrate-nitrogen is found to be so low that it is very difficult to detect it, but concentration of ammoniacal-nitrogen is such that it can be detected and differentiated easily. Further work is in progress.

(b) *Uptake of total nitrogen by the plant.*—Total nitrogen was estimated in different parts of the plants of 4 varieties (two improved strains of J.A.R.I. O40-632 (*olitorius*) and C39-212 (*capsularis*) against two standard strains C.G. (*olitorius*) and D154 (*capsularis*) grown under manured and unmanured conditions with three replications. Ten plants from each of the 24 plots selected at random were collected at pod stage and were cut into 3 equal portions—top, middle and bottom. Each of the three main stem portions, leaves from each portion, twigs and pods were analysed separately for each plot.

TABLE XXII

The nitrogen content of different parts of the jute plant.

Portions of the plant	Treatment	Percent total nitrogen on dry basis.			
		O40-632	C. G.	C39-212	D154
Top portions of the stem	*Manured	0.79	0.89	0.74	0.79
	Unmanured	0.64	0.55	0.63	0.59
Middle portions of the stem	Manured	0.55	0.40	0.58	0.51
	Unmanured	0.37	0.30	0.44	0.39
Bottom portions of the stem	Manured	0.40	0.40	0.53	0.38
	Unmanured	0.33	0.34	0.40	0.51
Top leaves	Manured	4.29	4.08	4.52	3.02
	Unmanured	4.01	3.62	4.97	3.72
Middle leaves	Manured	5.31	4.91	4.67	4.96
	Unmanured	4.83	3.92	3.99	4.86
Bottom leaves	Manured	3.68	3.67	3.54	3.61
	Unmanured	2.74	2.79	3.12	2.27
Pods	Manured	3.35	3.24	3.29	3.27
	Unmanured	2.67	2.67	3.32	2.92
Twigs	Manured	1.29	1.67	1.42	1.29
	Unmanured	1.07	0.90	1.64	1.12
Withdrawal by the whole plant (lbs/acre)**	Manured	74.3	104.0	131.3	95.4
	Unmanured	55.0	59.3	76.5	81.2

*Manured plots received 50 lbs N as ammonium sulphate whilst unmanured plots did not receive any fertiliser.

**The withdrawal by the leaves that have fallen before the samples were drawn were not taken into consideration.

It may be seen that usually plants from nitrogen treated plots contain more nitrogen and withdraw from the soil more nitrogen than plants grown in plots receiving no nitrogen. Further work is in progress.

5. Development of methods for determination of nutrients for advisory work in connection with manuring etc.

The method of determination of available phosphate by 0.15 normal sulphuric acid solution as developed last year

was further standardized and effect of storage of soil samples on the determination of nutrient status was studied. The results require further confirmation. Attempts are in progress for the development of a suitable quick method for the determination of available nitrogen for jute soils.

6. Role of soil conditions regarding susceptibility to diseases

It has been previously reported that it is not possible to differentiate jute soils of contiguous areas regarding susceptibility to diseases by determining major plant nutrients present in the soil (either available or total) or by pH, though in very dilute acid and very dilute alkali solutions soil samples from non-infected, slightly infected and infected plots behave differently. Application of ammonium sulphate often increases the incidence of disease whilst application of lime prevents it. Further, in jute-potato rotations, the incidence of disease is most. As the availability of boron present in the soil increases with the application of ammonium sulphate and decreases with liming and as the development of potato is much influenced by boron, these observations give an indirect evidence of the possible influence of boron in producing or controlling diseases. An experiment has been started with different doses of boron, zinc, copper, manganese, cobalt and molybdenum to study their influence on diseases of the jute crop. This work is being continued.

7. Attempts to find out the maximum production capacity of jute under the influence of nitrogen

Due to continuous spell of drought after sowing, the seeds germinated in instalments and this affected the yield considerably and though the trend is same as reported last year, the results were not statistically significant. Further work is in progress.

8. The influence of soil conditioners on soil texture

Krilium, a polyelectrolyte soil conditioner, was obtained this year through the courtesy of Messrs. Monsanto Chemical Company and included in the experiment this year along with

silicates, composts, tamarind seed powder, etc. and it was found tentatively that the water-holding capacity has increased with the application of Krilium and Tamarind seed powder. Further work is in progress.

VII. DISEASES.

1. Study Of The Effects Of Environmental Factors On Secondary Infection Due To *Macrophomina phaseoli*.

(i) Records of leaf infection from 6032 plants from different varieties of *C. capsularis* confirmed the previous finding that infection is always confined to the basal leaves. The leaves of all *capsularis* types have been found to be susceptible, though Nj-412 and Jap-Red are the most easily and severely attacked. The nature of cell-contents of the leaves of D154, Nj-412 and Jap-Red is being studied. No difference could be detected with regard to starch content.

(ii) The incidence of diseases in plants from different dates of sowing has been recorded. In the absence of meteorological data, the correlation studies could not be done. Analysis of data shows that early sown (15th March and 1st April) crop of the variety C.G. when attacked with stem-rot develop pycnidia on stem, while crops sown later (30th April and 15th May) though attacked with stem-rot did not develop pycnidia on the stem. This phenomenon is significant from the point of secondary dissemination by pycnospores.

2. Study Of The Stem-rot Fungus

(i) Eight forms of *Macrophomina phaseoli* were tested to assess their pathogenicity. Form B43, (from *C. olitorius* from Memari, Burdwan) proved highly virulent at the seedling stage under laboratory conditions. B-59 (from *C. olitorius* from Tarakeswar, Hooghly) which is the cause of epidemic root-rot, caused wilt mostly in late stages, under laboratory conditions. The latter proved more virulent than B-11 (from

C. capsularis from Chinsurah, Hooghly) and B-45 (from *C. capsularis* from Nilganj). All tests were carried with the improved strain O40-632 (*olitorius*) as the host. It appears that in Hooghly district at least two different physiological strains exist which are different from the one usually found in Nilganj farm.

(ii) The problem of epidemic root-rot in Hooghly district has become a serious one. The *Rhizoctonia* isolated from the epidemic-areas did not cause similar spread of root-rot in Nilganj farm when the inoculum was applied from pure culture on different media; but a similar 'epidemic' was artificially induced when water-infusion of the diseased jute plants from the epidemic areas was applied in the experimental plot in Nilganj. Reisolation yielded bacteria, *Fusarium* sp. and the usual pathogen—*Rhizoctonia*. The role of the *Fusarium* sp. and the bacteria in relation to epidemiology of the disease is under study. Pure cultures of 4 bacteria obtained from the diseased materials, did not cause any wilt in *C. olitorius*.

The jute (O40-632)—potato rotation plot was subdivided into 11 subplots; 8 of them were inoculated with the eight isolates of *M. phaseoli*, two with *Fusaria* and the eleventh plot was left as control. Mortality records did not show any difference amongst the plots inoculated with the different pathogens. In the *rabi* season potato was grown in the same field. From diseased potato plants and tubers *Rhizoctonia* (*M. phaseoli*), *Fusarium* sp. and bacteria were isolated.

The epidemiology of the root-rot disease is still obscure, except that it has been found that the strains collected from Hooghly have proved more virulent under laboratory conditions.

3. Other Diseases

(i) *Anthraxnose of jute*—It has been reported previously that *Colletotrichum* sp. attacks *capsularis* jute plant causing

serious damage. Study of the incidence of *anthracnose* on genetic strains show that all the known types of *C. olitorius* are immune to attack of the *Colletotrichum* sp. Several strains of *C. capsularis* have shown different degrees of resistance. In the study of the development of this new disease under field conditions, it was found that the different *capsularis* varieties and types could be divided into four groups according to the nature of the damages. The first group comprises of those which are attacked in early stages, usually in July; the sunken spots appear all over the stem, gradually enlarge and coalesce. The plant withers completely and the stem begins to rot. The second group is attacked only in the late stages after the formation of periderm. In this group the lesions are usually localised at the collar region or at least in the basal region of the stem. In severe cases the stems may break and the plants may die but localisation of the canker by callus formation is frequently seen. In the third group slightly sunken small black spots appear all over the stem in the middle of August which usually remain localised. In the fourth group the infection occurs only in the ovary or immature capsules.

The disease has been found to be seed borne. Hyphae have been detected in the inner portions of endosperm and often in the cotyledons. The seed-coat also has been found to be full of hyphae.

23 selections were tested for resistance to *anthracnose*. In 20 of the cultures mortality was above 80 per cent under artificially induced epidemic while three selections proved highly resistant. These were brought forward for large scale trial. Twelve crosses were made for the study of the inheritance of resistance.

Colletotrichum capsici reported to be a pathogen of jute in Malaya was compared with the *Colletotrichum* sp. isolated from jute at Nilganj. The cultural characteristics were compared on different media and were found to differ in many

characters. Both, however, failed to attack *Capsicum annum* the known host of *C. capsici*. The *Colletotrichum* from Nilganj readily infected jute under favourable field conditions.

Anatomical study of the diseased stem revealed that the disintegration of the cortex starts from the periphery and quickly travels through the medullary rays up to the cambium. The fibre bundles turn rusty brown and disintegrate slowly. Fibre extracted from spotted (diseased) plants yield 'specky' fibre, which fetches comparatively lower price.

(ii) *Soft-rot caused by Sclerotium rolfsii Sacc.*—Artificially multiplied sclerotia were applied in soil against a number of *C. olitorius* type materials grown in replicated randomized plots. Infection did not take place at any stage of development. Incidence of soft-rot, in general, was light during this season.

(iii) *Fusarium.*—The *Fusarium* sp. which had been found associated with *Macrophomina phaseoli* in the epidemic root-rot areas, was multiplied on artificial media and was introduced in soil against a crop of O40-632. The development of the disease indicated that the *Fusarium* sp. in Tarakeswar is a secondary pathogen. Further studies are being continued.

(iv) *Leaf scald.*—This disease was again observed in the fields and *C. olitorius* polyploid materials suffered most. As previously reported, no bacteria or fungus were found to be associated.

4. Chlorosis In Jute

Finlow first observed the yellow and light yellow patches on the leaf surface leading to variegated appearance and applied the term 'chlorosis' to describe the phenomenon. Investigations started in 1916 and continued for some years. Banerjee in 1924 described the F_1 s of crosses between chlorotic and non-chlorotic types and found that all the crosses gave a mixture of the two types. In 1939, Finlow while

reviewing the work on jute referred to chlorosis as a 'morphological imperfection' and suggested that concentrated attention should be given to the study of this phenomenon.

Work on this aspect has been started at the Jute Agricultural Research Institute. It has been found that plants may be chlorotic from the very early stages or may become chlorotic at later stages, at any time during the vegetative period of the plant. In mild form the imperfection is not directly harmful, but in severe cases, the leaves become crinkled and brittle and growth is checked.

The problem appears to be highly complicated and work on this phenomenon is being carried out in two directions to investigate its nature, *i.e.* (1) whether it is a virus disease transmitted through pollen or seed and/or (2) if it is a genetical phenomenon.

A number of grafts were made between chlorotic and non-chlorotic plants and *vice versa* using inarch and cleft methods of grafting. It was found that chlorosis was transmitted in both the directions, that is, the chlorotic stock transmitted chlorosis to the healthy scion and the chlorotic scion transmitted chlorosis to the healthy stock. It was, however, noticed that transmission was slightly delayed in the case of the latter.

True breeding chlorotic cultures have been established and crosses have been made between chlorotic and non-chlorotic plants in both the directions. The crosses between non-chlorotic $\times$ chlorotic failed to germinate. The germination in crosses between chlorotic $\times$ non-chlorotic was, however, good and all the F_1 progenies were chlorotic. Successful back-crosses of the F_1 s with both chlorotic and non-chlorotic parents have been obtained. Further work is in progress.

5. Investigation On The Methods Of Control Of Diseases

(i) *Selection and breeding of resistant types*.—29 selections from improved *capsularis* and 18 selections from improved *olitorius* strains and 40 selections from heterozygous *capsularis* material were sown in four separate randomized

replicated trials. Sowings were completed in the second week of May; germination was satisfactory but due to a severe drought extending over a period of 21 days a large number of the seedlings died. Artificial inoculation was given as usual. Due to poor stand and mixed infection of 'stem-rot' and 'anthracnose' a statistical analysis of the data had not been possible; 64 selections were brought forward on the basis of rate and intensity of infection and vigour.

A number of crosses were made in the previous season amongst the susceptible types, NJ-412 and Jap-Red, and the comparatively resistant types like D154, C39-212 and Jap G in *C. capsularis* and amongst the wild and cultivated types of *C. olitorius*. The F_1 s were raised in artificially infected soil. The stand was very poor and the surviving plants have been brought forward for further study. Due to heavy infection of *Colletotrichum* the seeds of the above selections and of the crosses were heavily damaged.

(ii) *Susceptibility of different varieties to disease*.—In order to assess the resistance in different improved strains undergoing final yield tests in large scale field experiment, records of incidence of disease was kept in the *capsularis* varietal trial.

TABLE XXIII.

Incidence of disease per cent.

Variety	Mean disease per cent.			
C.T. 919	...	...	...	15.59
D154	...	...	...	16.61
C42-Kj-321	...	...	...	16.81
C39-212	...	...	...	18.01
JR48-1	...	...	...	18.77
C.T. 918	...	...	...	20.97
C41-13	...	...	...	21.38

The differences were insignificant. C41-13 was, however, found to have been severely attacked by *anthracnose*.

(iii) *Susceptibility of some capsularis and olitorius improved strains due to nitrogen manuring.*—Observations were taken from the plots manured with equivalent quantities of sodium nitrate and ammonium sulphate. Incidence of disease was recorded in each plot by sample counts.

TABLE XXIV.

Showing mean percentage of disease caused by M. phaseoli

	Manured plots.	Unmanured plots.	For all plots.
C.G.	20.24	15.62	17.93
O40-632	10.23	9.08	9.65
Species Mean	15.70	12.35	13.79
C39-212	2.57	2.72	2.64
D154	1.70	4.06	2.90
Species Mean	2.14	3.29	2.76

The analysis of the data has shown that *C. olitorius* is more susceptible to 'collar-rot' and 'root-rot' than *C. capsularis* under Nilganj condition. Further, C.G. was comparatively more susceptible than O40-632. There was no difference between C39-212 and D154. Differences in manured and unmanured plots were not significant, neither that due to interaction of manure and varieties.

(iv) *Relative efficacy of some commercial fungicides.*—A replicated field trial was carried out with a susceptible variety to test the efficacy of some commercial fungicides. Altogether there were nine treatments including seed treatment and sprays.

In general seed treatment with Agrosan GN has been found to be fairly effective in giving protection to seedlings from secondary infection from soil. Seed treatment has, however, been found to give complete protection against seed-borne *M. phaseoli*. Both Perenox and Boardeaux mix-

ture were significantly effective against secondary infection due to air-borne spores. "Agricop" and "Colloidal copper" were found quite effective under laboratory conditions, but not under field conditions; probably their sticking property was altered under field conditions.

(v) *Population and incidence of disease.*—Records from the line vs. broadcast trial confirmed the previous observations. The spacing of $3'' \times 12''$ is most suitable from prophylactic point of view. It is assumed that manuring might support a larger number of plants in a row than under normal conditions where plants become thinner due to undernourishment when the number exceeds a particular limit. But it is found that incidence of disease and mortality are increased due to heavy manuring with nitrogenous fertilizers alone.

TABLE XXV.

Incidence of disease in the various treatments
(Mean disease per cent)
Fanduk

<i>Treatment</i>		<i>Manured</i>	<i>Unmanured</i>
Broadcast	... ..	18.99	8.55
Light thinning $\times 12''$	...	47.33	10.10
$2'' \times 12''$	...	28.75	17.66
$3'' \times 12''$	...	20.82	10.61

D154

Broadcast	... ..	20.79	10.24
Light thinning $\times 12''$	...	37.97	22.71
$2'' \times 12''$	...	27.70	8.20
$3'' \times 12''$	...	16.32	6.93

S.E. % ... 21.82

C. D. ... 10.50

6. Storage Of Seeds

It was previously shown that jute seeds lose viability very rapidly when stored without proper sunning. It was also found that when kept in airtight containers the seeds retained their viability longer. In order to find out a suitable container for storage, jute seeds of 1951 were stored in (i) ordinary gunny bags (single), (ii) ordinary gunny bags (double), (iii) 'Alkathene' (plastic) lined bags, and (iv) kraft-paper lined bags. The seeds were stored in 1952 and the germination was tested on 13-2-54. Samples for germination test were taken from two regions from each bag, (i) the peripheral layer upto 4 inches, and (ii) the central layer. It has been found that gunny bags, both double and single, and kraft-paper lined bags are not quite suitable for storing jute seeds, as viability deteriorated considerably even after two years' storage. In all these cases, it has been observed that seeds of the inner layer retained their viability longer than those of the outer layers. Seeds from the outer layer of single and double gunny bags completely lost their viability, while seeds from the outer layer of kraft-paper lined bags retained their viability only to a small extent. In 'Alkathene' lined bags, however, the seeds did not lose their viability and there was practically no difference between the outer and inner layers of seeds. Further work on the effects of storage is in progress.

VIII. PESTS.

Nupserha bicolor ssp. *postbrunnea*.—Since the record of this pest in *olitorius* jute in 1949, it has spread extensively in subsequent years. Attempts are being made to ascertain (i) whether the subspecies is endemic or exotic and (ii) as to how the insect has become a pest on jute. In connection with the former study, a survey was made during the last four years to find out the alternative host plants (other than

olitorius jute) of the pest and the following have so far been recorded:—

<i>Name of the alternative host plant.</i>	<i>Family.</i>
1. <i>Sesbania aegyptiaca</i>	Leguminosae
2. <i>S. aculeata</i>	„
3. <i>Sesbania</i> sp.	„
4. <i>Crotalaria juncea</i>	„
5. <i>C. saltiana</i>	„
6. <i>Aeschynomene aspera</i>	„
7. <i>Hibiscus cannabinus</i>	Malvaceae.

Relative preference shown by the pest to each of these alternative hosts was determined and *S. aegyptiaca* was found to be its favourite host. Almost all the branches of the host are subject to oviposition and consequent damage. The fact, that the genus *Nupserha* is oriental in distribution and the favourite host *S. aegyptiaca* occurs in wild state in India, suggests that the pest is probably endemic and not an exotic type of foreign origin.

With sudden increase in acreage of fibre producing crops like jute, sunn-hemp and mesta immediately after partition in 1947, it is probable that these fibre crops were brought within the flight range of the insect feeding on *S. aegyptiaca*. The insect tried all these crops as its food. It found *olitorius* jute as most suitable and, therefore, established firmly on this crop as an important pest.

Female genital organ and its role in causing damage.—

As egg laying and damage are inseparably connected unlike the other pests of jute, genitalia of the female was studied in considerable detail. For this purpose microtome sections of mature females were cut and the genitalia and other features of the reproductive organs were examined. Dissections were also made under the stereoscopic microscope for study of the genitalia and the reproductive organ as a whole. Numerous structural modifications were found in the genitalia so as to adapt itself for depositing the egg inside the stem. Besides, it appears that the hormonal secretion of the mature

gonads of the female imparts a functional change in the behaviour of its mandibles. As a result, the mandibles of the female act as accessory genital organ. The mandibles cut the rings and the slit on the stem during pre-ovipositional operation and thus cause the damage. Some of the structural characteristics of the genitalia are: (a) presence of a ball and socket joint in a tergite ; (b) fusion of the tergite and sternite into a cylindrical chitinous capsule which remains hidden inside the abdomen when at rest ; (c) chitination of the inner wall of the capsule has been very modified into rows of annular thickening which enable the capsule to be crumpled and to be everted out during oviposition ; (d) at the time of egg laying, the capsule and the valves evert out and thus the genital opening is placed far beyond the tip of the abdomen. The capsule and the valves are pushed through the central pit of the slit, cut on the stem by the mandibles during pre-ovipositional operation.

Study on the slit reveals that it is made by two indentations of the mandibles. The inner two punctures are so made as to coalesce to form a central pit which is bordered by two lateral punctures.

Measurement of the width of the central pit and the lateral punctures of the slit and the base of the valves and capsule show that only the central pit can be used as the passage for oviposition as shown below:

Width in mm.				
Slit	{	left puncture	...	0.241
		right „	...	0.293
		central pit	...	0.613
Capsule	...	...	...	0.420
Valves	...	...	...	0.347

Effect of larval (borer) and adult feeding on the host.—In case of all other pests of jute, damage is associated with the larval or adult feeding. In case of *N. bicolor* ssp. *postbrunnea*, feeding by the borer larva or by the adult has no visible adverse effect on the host plant. The borer larva,

on hatching inside the stem, starts feeding on the pith tissue which is either dead or destined to be disintegrated in course of time. Feeding on such a tissue has no adverse effect on the host and the plant with the borer inside can grow well without showing any adverse symptom. The borer larva may at times feed upon a little amount of woody tissue. Adults remove portions of veins of leaves or feed upon the surface tissues (upto cortex) of the ridges on the young stems. Such feeding, in fact, does not interfere with the general growth of the plant.

Larval diapause.—Larva enters diapause during its last instar at the advent of winter and shrinks to nearly $2/3$ of its original length in this stage. Diapause stage is passed within the dry stem under the laboratory condition. Attempts were made to find out where this stage is passed under the field condition. About 5000 stubbles of *olitorius* jute were examined, but none could be found in any of them.

Effect of different common insecticides on the adults.—Different common insecticides were tried on the adults under the laboratory conditions to find out their efficacy in causing the mortality of the adult. Both BHC and DDT are equally effective under the laboratory conditions. Efficiency of insecticides (BHC and DDT) in the form of dust and water suspension under the field condition will be tested in the following season.

Effect of temperature in initiating diapause.—The study was conducted with a number of larvae in their prediapause stage. The sets of larvae maintained under the controlled temperature of 30°C which is more or less equivalent to the summer room temperature, entered diapause like the other sets maintained under the normal winter temperature of the room.

Thus it was observed that temperature had no effect on the onset of diapause stage.

Parasite.—Observation on the extent of parasitization by different parasites on *Nupserha* was continued. It was found

that natural parasitization increased considerably in comparison with that of the previous year. Increase in population of the parasites also suggests an increase in the density of the host population namely, *N. bicolor* ssp. *postbrunnea*. Of the different parasites, *Neocatolaccus* sp. has shown the maximum activity during the season by parasitising 31.56 per cent. Maximum parasitization to the extent of 22.12 per cent. by this parasite was done during the month of August.

Because of the efficiency of *Neocatolaccus* sp. as an effective parasite, attempts were made to breed the parasite under the laboratory condition for further observation. It was not possible to raise more than one generation on the *Nupserha* host. Search is being made to find out suitable alternative host for laboratory breeding. Preliminary observation made on the parasite shows that the female thrusts its strong and stout ovipositor through the stem tissues and deposits the egg on the body wall of the larva or the pupa. How the female locates the host inside the stem is not yet clearly understood. Incubation period of egg is about 24 hours, larval period 6 days and the pupal period is variable being about 9 days on an average. Sexual dimorphism is visibly manifested from the pupal stage.

Effect of different dates of sowing on the incidence of major pests of jute.—Sowings of the trial were done at about 20 days interval starting from 16th March. Last sowing was done on the 24th June. There were altogether six sowings. Periodical records were kept from the *capsularis* crops on the extent of attack of *Laphygma exigua*, *Apion corchori*, *Anomis sabulifera* and *Hemitarsonemus latus*. Incidences of these pests on crop raised during different periods are in same line as in previous years.

TABLE XXVI.

*Effect of different dates of sowing on the extent of attack by
L. exigua in per cent.*

Dates of sowing	D 154				Fanduk			
	1 month old	2 months old	3 months old	4 months old	1 month old	2 months old	3 months old	4 months old
16-3-53	3.99	3.05	0.00	0.00	3.24	3.43	0.00	0.00
5-4-53	3.00	0.00	0.00	0.00	3.54	0.00	0.00	0.00
25-4-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15-5-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4-6-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-6-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE XXVII.

*Effect of different dates of sowing on the extent of attack
by A. corchori in per cent.*

Dates of sowing	D154				Fanduk			
	1 month old	2 months old	3 months old	4 months old	1 month old	2 months old	3 months old	4 months old
16-3-53	0.76	5.80	45.19	6.11	1.29	7.19	35.85	7.05
5-4-53	1.58	27.11	26.48	5.15	2.06	25.37	30.55	3.20
25-4-53	12.95	14.23	20.83	9.73	12.68	22.99	12.45	6.12
15-5-53	...	7.19	13.78	19.33	...	6.25	16.63	18.72
4-6-53	2.45	7.00	8.25	15.79	1.95	3.46	8.21	11.50
24-6-53	1.99	1.80	1.79	4.49	1.69	2.42	0.59	2.95

TABLE XXVIII.

*Effect of different dates of sowing on the extent of attack
by A. sabulifera in per cent.*

Dates of sowing	D154				Fanduk			
	1 month old	2 months old	3 months old	4 months old	1 month old	2 months old	3 months old	4 months old
16-3-53	0.00	0.00	0.00	8.44	0.00	0.00	0.00	8.52
5-4-53	0.00	0.00	2.05	2.56	0.00	0.00	1.98	2.74
25-4-53	0.24	7.00	20.74	0.00	0.21	9.54	15.17	0.00
15-5-53	0.00	21.48	7.24	0.00	0.00	28.28	4.60	0.00
4-6-53	3.23	1.63	0.00	0.00	1.60	1.02	0.00	0.00
24-6-53	0.49	0.00	0.00	0.00	0.92	0.00	0.00	0.00

TABLE XXIX.

*Effect of different dates of sowing on the extent of attack
by H. latus in per cent.*

Dates of sowing	D154				Fanduk			
	1 month old	2 months old	3 months old	4 months old	1 month old	2 months old	3 months old	4 months old
16-3-53	0.00	7.33	11.90	0.00	0.00	6.70	4.26	0.00
5-4-53	0.00	8.62	0.00	0.00	0.00	5.34	0.47	0.00
25-4-53	0.00	1.20	0.00	0.00	0.00	1.08	0.97	0.00
15-5-53	0.00	0.00	1.46	0.00	0.00	0.00	0.00	0.00
4-6-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24-6-53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Selection for Apion resistance.—No differences have been observed on *Apion* resistance amongst selections of X-irradiated plants (with dosages upto 20,000 r unit) of both *capsularis* (D154) and *olitorius* (C.G.) materials.

New records.—The following pests have been recorded for the first time on jute and are under observation,

- (1) White fly (Fam. Aleurodidae)
- (2) Stem-borer-*Sybra praeusta* Pase. (Fam. Lamiidae)

IX. THE JUTE PEST AND DISEASE CONTROL SCHEME, TARAKESWAR

An area of 304.5 bighas (101.5 acres) of cultivators' land of which 247 bighas (82.3 acres) were under jute (*C. olitorius*), was brought under the scope of the study of control measures. The sowing period extended from 2nd May to 25th May and in some cases it went upto 6th June. 80 per cent of sowings were completed by the 14th May.

Nearly 9 bighas (3 acres) of land was sown in lines with the help of jute seed drill, as demonstration crop. Except one thinning and weeding operation by hand in the early stage, rest of the interculture was given with wheel-hoe. A top dressing with ammonium sulphate at 40 lb. N per acre was given between rows. The improved strain O40-632 was used in all line sown plots. The use of improved seed, fertilizer and practice of row cropping resulted in a tall and uniform crop. The average yield from the row plots was 66 per cent higher than the normal cultivators' crop during 1952. At the close of the season the cultivators came in increasing numbers with indents for drills, wheel-hoes and particularly improved seeds for 1954-55 season.

Diseases.—The study of the development of disease showed that root-rot started with heavy showers in the month of June. Mortality was highest in water-logged areas. Isolation on culture media yielded *Rhizoctonia*, *Fusarium* and bacteria. The typical root-rot due to *Rhizoctonia* alone is always dry-rot; whereas in Tarakeswar area the affected plants often show symptoms of bacterial infection. Although the major pathogen is *Rhizoctonia*, the secondary role played by *Fusarium* and bacteria are considered to be important.

Intensive control measures were undertaken in 10 cultivators' plots where records of incidence were kept at regular intervals. Records indicate that due to the prophylactic measures and improved methods of agriculture which included removal of diseased stubbles, seed treatment, use of soil correctives like lime and potash, application of fertilizer like ammonium sulphate, clean cultivation, timely thinning, weeding and sprays, there has been a gradual decrease in the incidence of diseases and corresponding increase in yield.

TABLE XXX

Results of three years records of disease and yield
(I=Per cent disease.) II=Yield per bigha in maunds.
(1 bigha=0.33 acre)

Plot No.		1950	1951	1952	1953
654 (1 bigha)	I	20-30%	9.0%	9.6%	4.4%
	II	...	...	...	...
567 (1 bigha)	I	20-30	9.3	9.5	0.9
	II	...	4.0	5.6	8.4
282 (1 bigha 5 Kot.)	I	15-20	8.0	7.0	2.7
	II	...	5.6	6.8	7.3
286 (1 bigha)	I	20-30	14.3	6.5	3.0
	II	...	4.5	6.7	7.7
33 (16 kot.)	I	Above 40	18.8	7.2	4.8
	II	...	3.8	4.6	8.1
25 (8 kot.)	I	Above 40	9.1	8.7	6.1
	II	...	5.3	5.4	6.7
564 (1 bigha)	I	20-30	Not recorded	11.1	11.9
	II	...	3.3	7.9	9.8
30 A and B (16 kot.)	I	20-30	16.3	12.0	7.6
	II	...	5.0	4.4	8.8
283 & 284 (1 bigha)	I	40 and above	30.0	10.5	3.8
	II	...	3.0	7.2	8.0
19 (18 kot.)	I	Above 40	12.4	Paddy	Paddy
	II	...	6.1	5.5	8.0

In many cases, although the incidence could not be appreciably reduced, mortality was greatly checked; thus providing higher yield.

The cultivation of jute and potato in the same field every year favours epidemic root-rot in jute. The problem is complex and needs more co-operation from cultivators to investigate the causes and combat them.

Pests.—Cultivators of the locality have become very much conscious about damages done by pests. Plant protection is becoming increasingly popular and 47 cultivators were taught the use of dusters and sprayers which were supplied to them for temporary use. Incidence of pests was much less during the season. The Table below shows the extent and acreage under attack by *H. latus* and *A. sabulifera* in the locality. It is based on observations made on 247 bighas or 82.3 acres.

TABLE XXXI.

Per cent of incidence	Acerage under attack	
	<i>H. latus</i>	<i>A. sabulifera</i>
1—3	1.4	1.8
4—20	2.6	3.3
21—40	2.8	4.3
41 and above	1.3	26.1

From a small trial conducted in the locality, it has been found that decrease in yield due to pest damage has been to the extent of 1.5 maunds per acre during the year under report.

X. SUBSTITUTE FIBRES

I. BOTANICAL AND AGRONOMICAL STUDIES

Collection of types

18 fresh samples of seeds and other propagative materials of different fibre crops, both indigenous and exotic, were received. The additions were as follows:—*Hibiscus cannabinus*—3 samples, one each from Nepal, Purnea and Ibadan; *Hibiscus sabdariffa*—6 from Tripura State and 1 from Nigeria;

one sample each of *Hibiscus lunarifolius*, *Hibiscus panduraeformis* and *Hibiscus surratensis* from Kenya Colony; *Crotalaria anagyroides*—1 from Ceylon, *C. incana*—1 from Kenya Colony and 1 from Southern Rhodesia; *C. verrucosa*—1 from S. Rhodesia; and *Boehmeria nivea*—100 slips from Barbhetta Farm, Assam.

Of the 3 new samples of *H. cannabinnus*, seeds from Purnea and Ibadan and the seeds of *H. lunarifolius*, *H. panduraeformis* and *H. surratensis* received from Kenya Colony failed to germinate. Seeds of *Crotalaria anagyroides* received from Colombo showed very poor germination. The performance of a few plants raised from these seeds has, however, been found to be satisfactory during their first year of growth at Nilganj. The samples of *Crotalaria incana* received from Kenya Colony gave about 80% germination, whereas, the sample from Southern Rhodesia did not germinate. Seeds of *C. striata* and *C. verrucosa* obtained from Southern Rhodesia showed 27.7 and 12.7% germination respectively and they will be sown next year to study their growth performances.

The fibre percentages based on the green weight of the different fibre plants under observation are given below:—

			Fibre %
1.	<i>Hibiscus cannabinnus</i>	... ..	4.5
2.	<i>H. sabdariffa</i> (green)	... ..	4.38
3.	<i>H. sabdariffa</i> (green pigmented)	... ..	4.51
4.	<i>H. esculentus</i>	... ..	2.07
5.	<i>H. vitifolius</i>	... ..	1.11
6.	<i>Abutilon indicum</i>	... ..	2.96
7.	<i>Malachra capitata</i>	... ..	2.39
8.	<i>Urena lobata</i>	... ..	2.47
9.	<i>U. sinuata</i>	... ..	4.03
10.	<i>Crotalaria juncea</i>	... ..	2.82
11.	<i>Sesbania aculeata</i>	... ..	2.03
12.	<i>Sida rhombifolia</i>	... ..	2.53

STUDIES ON HIBISCUS SP.

1. Breeding and Genetics

(i) *Isolation and selection of types*.—In *H. cannabinus*, 223 selections brought forward from the purification series of last year, were grown for further observation. As a result of an attack of stem-rot, the progenies of about 30 of these selections were lost even after intensive remedial measures. The progenies of the remaining cultures were studied with regard to such characters as pigmentation pattern, plant height, base diameter, leaf shape, earliness and resistance to diseases, pests and water-logging. Progenies of 169 of these selections have been found to be breeding true. 500 selections were made from these cultures for further study.

250 fresh selections based on maturity, pigmentation pattern on plant parts, leaf shape, plant height, base diameter and resistance to diseases, pests and water-logging were made in *H. cannabinus* from the different foreign and indigenous collections. Of these, 15 selections were made from Nigerian material with flowers having white stigma with light pink (almost white) centre recorded for the first time in our collections.

115 selections in *H. sabdariffa* from the non-bristled cultures were brought forward and grown for further study. 73 selections based on plant height and base diameter from these non-bristled cultures were made with a view to evolve a high yielding non-bristled strain.

152 other selections in *H. sabdariffa* from the purification series were also brought forward and grown for observation during the season. The progenies of all these selections were studied with regard to their individual characters such as pigmentation of plant parts, plant height, base diameter and leaf shape. Progenies of all these cultures have been found to be breeding true. 252 selections have been made from these cultures for further study and some of the promising selections will be included in yield trials during the next season.

(ii) *Interspecific hybridization*.—Seeds obtained from 100 crosses between *Hibiscus radiatus* × *H. cannabinus* were grown. Germination of the F_1 s was satisfactory. 50 back crosses with both *H. radiatus* and *H. cannabinus* were also attempted. For determining the male sterility of F_1 s, 50 crosses were made with both *H. radiatus* and *H. cannabinus* using the F_1 s as male parent.

800 fresh interspecific crosses between different species of *Hibiscus* were attempted particularly with a view to combine the economic characters of some of these species like resistance to diseases, pests and water-logging with such characters as good quality and high yield of some of the selected types of *H. cannabinus*. A number of successful interspecific crosses between *H. radiatus* and *H. cannabinus* have been obtained. Crossing between other species has not given any encouraging results.

(iii) *Small scale yield trial of H. cannabinus*.—This trial was repeated with two local selections against two foreign strains as in last year. The results are given in the following table.

TABLE XXXII

Yield trial of H. cannabinus

Layout—Replicated randomized blocks in 6 replications

Effective plot size—1/414 acre

Date of sowing—5-5-53

Treatments	Fibre yield per acre (Mā.)	Percent on control	Date of harvest.
Mesta Grade 3	... 18.34	108.91	4-9-53
Mesta Grade 5 (control)	... 16.84	100.00	4-9-53
Kenaf (La-plantation, U.S.A.)	... 14.56	86.46	28-9-53
Kenaf (India Supply Mission, U.S.A.)	... 12.48	74.11	28-9-53
P	... 0.01		
C.D.	... 3.75		
S.E.%	... 5.76		

The observed differences in the yield of fibre are significant. The selection Grade 3 has given the highest yield of fibre but

it is at par with Grade 5. As in the previous year the two local selections were found to be two weeks earlier than the exotic ones.

(iv) *Varietal trial of H. sabdariffa*.—A varietal trial of 3 selected strains of *H. sabdariffa* and two types collected from Midnapore against the control *H. sabdariffa*. var. *altissima* was conducted in replicated randomized blocks. The results are given in the following table.

TABLE XXXIII
Varietal trial of H. sabdariffa

Layout—Replicated randomized blocks with 4 replications

Effective plot size—1/71 acre

Date of sowing—6-5-53

Varieties			Fibre yield per acre (Md.)	Percent on control	Date of harvest
MH-2	...	...	27.17	108.51	25-11-53
MH-4	...	...	26.96	107.67	25-11-53
Green pigmented	...	...	26.78	106.95	26-11-53
Green (var. <i>altissima</i>)	...	...	25.04	100.00	25-11-53
Chandrapat	...	...	24.53	97.96	30-11-53
Goldcoast	...	...	17.00	67.89	8-12-53
P	...	...	0.01		
C.D.	...	...	5.11		
S.E.%	...	...	4.99		

The type MH-2 has given the maximum fibre yield, but it is at par with all the other varieties except Goldcoast which has given about 22% lower yield of fibre than the control.

(v) *Anthocyanin pigmentation*.—The F_2 s, back crosses, fresh crosses and parents for the study of the inheritance of different pigment patterns in *H. cannabinus* and *H. sabdariffa* were sown. In *H. cannabinus*, all the cultures had extremely poor germination and no F_2 and back cross families could be classified. All the F_1 progenies obtained as a result of last year's winter crossing in *H. cannabinus* for pigmentation study were found to be segregating and, therefore, rejected.

207 F_2 families and 101 back cross families were studied and classified in *H. sabdariffa*.

90 fresh crosses and 132 back crosses were made in *H. sabdariffa* and 24 and 23 successful fresh and back crosses respectively were obtained. They will be grown and studied next year.

(vi) *Inheritance of earliness*.—*H. cannabinus*—37 crosses between early-maturing Chinese and Russian types with late-maturing and high-yielding local and American strains obtained last year were grown. Germination in F_1 s was poor. 33 back crosses with both types were attempted and 10 successful back crosses were carried forward for further study. 97 fresh crosses between the same materials were attempted and 25 successful crosses have been carried forward.

(vii) *Leaf shape character*.—20 F_2 families and 12 back cross families between the palmately-lobed and partially-lobed types of leaves in *H. sabdariffa* were grown and classified. A monogenic difference, between the palmately-lobed and partially-lobed types, controlled by a single factor pair which may be termed as L_1-l_1 (L_1L_1 = palmately-lobed, l_1l_1 = partially-lobed), was obtained.

2. Agronomical studies

(i) *Date of sowing experiment*.—This experiment was conducted in replicated randomized blocks with 4 replications with both *H. cannabinus* and *H. sabdariffa* var. *altissima* sown at intervals of 14 days in alternate lines in small plots. Effects of seasonal variations on the growth, development and first flowering of the crop were noted throughout the year. The data have been statistically analysed in both the cases and the test is significant at 1% level of probability. In *H. cannabinus*, though April first week sowing has given the maximum plant height, base diameter, green weight and fibre yield, it is statistically at par with the other sowings of March and April. It is, however, noted that in sowings beyond the first week of April there is a gradual decrease in the yield of fibre, green weight, plant height and base diameter. It has been found that *H. cannabinus* in general is not much affected by drought.

In *H. sabdariffa*, March first week sowing has given the highest plant height, base diameter, green weight and fibre yield but there is no significant difference between the sowings

from March to the middle of April. It is also interesting to note that in sowings after the first week of March the fibre yield, green weight, plant height and base diameter progressively decrease.

The co-efficients of correlation between plant height and fibre yield and between base diameter of plant and fibre yield have been found to be positive in both Mesta and Roselle. In the case of *H. cannabinus* it is 0.81 between plant height and fibre yield and 0.99 between base diameter and fibre yield ; and in *H. sabdariffa* var. *altissima* it is 0.95 and 0.89 respectively.

(ii) *Seed-rate experiment with H. cannabinus.*—This experiment was repeated during the year to determine the optimum seed-rate for Mesta with eight different seed-rates ranging from 5 lb. to 40 lb. per acre as in the previous year. The results are given in the following table.

TABLE XXXIV

Seed-rate experiment with H. cannabinus.

Layout—Replicated randomized blocks in 5 replications.

Effective plot size—1/414 acre.

Date of sowing—5.5.53.

Date of harvest—14.9.53.

Seed rate	Stand per acre	Av. height of plant (ft.)	Av. B. D. of plant (cm.)	Green wt. per acre (Md.)	Fibre yield per acre (Md.)
5 lb.	48188	8.84	1.74	358.53	18.06
10 lb.	67064	8.56	1.51	361.86	18.38
15 lb.	92928	7.80	1.36	337.44	16.71
20 lb.	110624	7.62	1.28	339.66	15.81
25 lb.	115071	7.85	1.24	334.11	15.71
30 lb.	95196	7.76	1.27	283.05	14.24
35 lb.	100914	7.63	1.25	271.95	13.19
40 lb.	115162	6.99	1.20	260.85	11.97
P	0.01	0.01	0.01	0.01	0.01
C. D.	43259	0.82	0.21	83.64	4.11
S. E. %	11.90	2.66	3.98	6.73	6.79

The differences with respect to stand per acre, average plant height, base diameter, green weight and fibre yield are all highly significant. The maximum fibre yield is obtained with 10 lb. per acre, though it is statistically at par with other seed-rates ranging from 5 lb. to 25 lb. per acre. With the increase in seed-rates there is a general increase in stand per acre usually accompanied by a fall in the average base diameter, plant height, green weight and fibre yield per acre.

(iii) *Seed-rate experiment with H. sabdariffa*.—The experiment was started in 1952-53 and was repeated during the year.

TABLE XXXV

Seed-rate experiment with H. sabdariffa.

Layout—Replicated randomized blocks in 5 replications.

Effective plot size—1/150 acre.

Date of sowing—8.5.53.

Date of harvesting—27.11.53.

Seed rate per acre.	Theoretical stand (at 80% germination) per acre.	Actual stand at harvest per acre.	Mortality percentage.	Av. ht. of plant (ft.)	Av. B. D. of plant (Cm.)	Green wt. per acre (Md.)	Fibre yield per acre (Md.)
5 lb.	90800	73348	19.22	11.21	1.58	527.90	26.72
10 lb.	181600	140957	22.38	9.15	1.16	554.28	29.38
15 lb.	272400	202924	25.51	8.85	1.07	568.40	28.17
20 lb.	363200	246116	32.32	7.71	0.90	524.93	26.55
25 lb.	454000	264819	41.67	8.16	0.95	543.50	26.80
30 lb.	544800	313342	42.48	6.91	0.77	553.54	26.14
35 lb.	635600	347518	45.32	7.39	0.83	509.70	22.93
40 lb.	726400	359611	50.49	7.54	0.86	572.48	24.52
P		0.01		0.01	0.01	Large	Large
C. D.		106927		1.63	0.29	...	...
S. E. %		11.37		4.99	7.29	5.19	5.91

The results may be summarised as follows :—

- (a) No significant differences have been obtained between the different seed-rates with respect to green weight and fibre yield.
- (b) Significant differences have been obtained due to different seed-rates with respect to stand per acre, average plant height and base diameter.
- (c) With the increase of seed-rates, there is a progressive decrease of plant height and base diameter except in a few cases.
- (d) Mortality of plants increases with the gradual increase in seed-rates.

(iv) *Spacing trial with H. sabdariffa var. altissima*.—This trial with 15 different combinations of spacings in replicated randomized blocks with 4 replications was a repetition of the previous year's trial and the results are given in the following table.

TABLE XXXVI

Spacing trial with H. sabdariffa var. altissima.

Layout—replicated randomized blocks with 4 replications.

Effective plot size—1/300 acre.

Date of sowing—8.5.53.

Date of harvest—1.12.53.

Spacing.	Theoretical stand per acre	Actual stand per acre at harvest	Mortality percentage	Av. ht. of plant (ft.)	Av. B. D. of plant (cm.)	Fibre yield per acre (Md.)
4" x 2"	784080	379480	51.65	8.34	1.38	23.46
4" x 4"	392040	247967	36.75	9.41	1.56	26.45
4" x 6"	261360	177652	32.03	10.13	1.68	28.48
6" x 2"	522770	310801	40.48	9.03	1.50	25.59
6" x 4"	261360	178669	31.64	11.12	1.84	31.25
6" x 6"	174240	144692	16.96	11.28	1.87	31.70
9" x 2"	348480	198053	43.17	10.16	1.68	28.55
9" x 4"	174240	121605	30.21	10.68	1.77	30.03
9" x 6"	116160	100043	13.87	11.30	1.87	31.76
12" x 2"	261360	164875	36.92	11.12	1.84	31.27
12" x 4"	130680	100860	22.82	11.67	1.82	30.76
12" x 6"	87120	71293	18.12	12.11	2.01	34.05
15" x 2"	209088	151153	27.29	9.86	1.64	27.73
15" x 4"	104544	86394	17.36	11.07	1.84	31.11
15" x 6"	69696	62509	10.31	11.29	1.87	31.73
P		0.01		0.01	0.01	0.01
C. D.		75807		2.17	0.36	6.10
S. E. %		11.83		6.25	7.43	5.42

The observed differences with regard to average plant height, base diameter, stand per acre and fibre yield due to the different spacings, both in and between lines, are significant at 1% level of probability. The highest fibre yields are obtained with 6" spacings within the line irrespective of spacings between the lines, the maximum being with the spacing 12" between and 6" within the line.

It is interesting to note that with the increase in the spacing within the line the average height, base diameter of plants and fibre yield generally increase while the mortality decreases.

(v) *Trial of spacing-cum-stages of harvest with H. sabdariffa var. altissima.*—This experiment was a repetition of the trial conducted last year. The differences in fibre yield between the main treatments (spacings) and sub-treatments (stages of harvest) were insignificant.

(vi) *Manurial trial with Hibiscus sabdariffa.*—A manurial trial was conducted in replicated randomized blocks with 4 replications during the year to study the effect of N.P.K. (applied singly and in combinations) and lime on the yield and quality of fibre. The test was insignificant and no conclusion could be drawn.

(vii) *Combined yield trial of different fibre crops.*—In a combined yield trial with mesta, roselle, *Malachra* and jute conducted in replicated randomized blocks in 4 replications as in last year roselle (G.P.) gave significantly higher yield of fibre than that of jute (D 154), mesta (Gr. 5) and *Malachra*, but it is statistically as good as roselle (green), kenaf (L-plantation) and jute (C.G.).

Quality tests :

Results of the quality tests of fibres of some trials received from T.R.L. during the year under report are given below:—

TABLE XXXVII.

Experiment—Seed rate experiment with *Hibiscus cannabinus* (1952)

Treatments					Quality ratio
5 lb./acre	...	...	...	...	77
10 " "	...	...	...	...	72
15 " "	...	...	...	...	80
20 " "	...	...	...	...	82
25 " "	...	...	...	...	81
30 " "	...	...	...	...	80
35 " "	...	...	...	...	69
40 " "	...	...	...	...	73

Experiment—Seed rate experiment with *Hibiscus sabdariffa* (1952).

Treatments					Quality ratio
5 lb./acre	...	...	...	...	72 $\pm$ 1.4
10 " "	...	...	...	...	90 $\pm$ 1.8
15 " "	...	...	...	...	75 $\pm$ 0.8
20 " "	...	...	...	...	82 $\pm$ 1.2
25 " "	...	...	...	...	80 $\pm$ 1.6
30 " "	...	...	...	...	83 $\pm$ 0.9
35 " "	...	...	...	...	81 $\pm$ 1.4
40 " "	...	...	...	...	89 $\pm$ 1.2

Experiment—Varietal trial of *H. sabdariffa* (1952)

Chandrapat	...	...	...	71 $\pm$ 1.0
Green pigmented	...	...	...	86 $\pm$ 1.3
Green	...	...	...	70 $\pm$ 1.3
Goldecoat	...	...	...	66 $\pm$ 1.2

Experiment—*Line Vs. Broadcast experiment of H. sabdariffa var. altissima (1952)*

Bud stage :					
Broadcast	...	...	...		81 ± 1.5
No thinning $\times 12''$	...	...	...		72 ± 1.0
$2'' \times 12''$	...	...	...		67 ± 1.5
$4'' \times 12''$	...	...	...		69 ± 1.1
$6'' \times 12''$	...	...	...		71 ± 1.8
Flower stage :					
Broadcast	...	...	...		64 ± 1.0
No thinning $\times 12''$	...	...	...		66 ± 1.2
$2'' \times 12''$	...	...	...		61 ± 0.8
$4'' \times 12''$	...	...	...		60 ± 0.7
$6'' \times 12''$	...	...	...		60 ± 1.4
Pod stage :					
Broadcast	...	...	...		68 ± 1.4
No thinning $\times 12''$	...	...	...		59 ± 1.2
$2'' \times 12''$	...	...	...		60 ± 1.0
$4'' \times 12''$	...	...	...		56 ± 1.3
$6'' \times 12''$	...	...	...		55 ± 1.6

Experiment—*Yield trial with different fibre crops (1952).*

Sunn hemp (Bullandshar)	...		45
Sunn hemp (Jabalpur)	...		50
Mesta (Gr. 5)	...		80
Roselle (Green)	...		75
Roselle (G. P.)	...		65
Jute (C. G.)	...		88
Jute (D154)	...		105

3. Studies on other fibres

(i) *Sunn-hemp*—Morphological observations on 10 types of sunn-hemp collections have been recorded. Seeds of all the types of sunn-hemp were also multiplied during the winter season.

Small quantity of the seeds of *Crotalaria anagyroides* received from Colombo was sown during the season. The plants have been growing for the last 7 months and are still in their vegetative phase.

(ii) *Linseed*—(a) *Agro-botanical characteristics*—Agro-botanical characteristics of the different flax X linseed hybrid collections have been recorded. Some of the I.A.R.I. collections have again been found to be segregating this year with regard to the colour of corolla, filament, anther, style, stigma and seed-coat. Attempts for purifying these cultures by roguing have been made.

(b) *Yield trial of Linseed strains*—A trial of linseed was conducted with 17 strains as in the last year in replicated randomized blocks with 5 replications. It has been found that one of the I.A.R.I. strains Flax tall X Linseed N. C. 3 has given the highest yield of both straw and seed. As regard straw yield it is, however, at par with 14 other strains included in the test.

(iii) *Ramie and other nettle fibres*.—Fresh Ramie slips obtained from cuttings and also seedlings raised from seeds have been added to the plantation started last year. More Ramie slips obtained from Assam have been planted. As degumming of ramie fibre cannot be successfully done by ordinary retting process, attempts have been made to evolve simple methods of degumming by the use of various chemicals and such natural substances like tamarind extract, enzymes from mixed cultures obtained from rotting fruits of *Putranjiba roxburghi*, orange, pineapple etc. Of these various treatments, chemical degumming with 6% sulphuric acid in cold followed by bleaching has been found to be both economical and practical.

Fibres have successfully been extracted from *Girardinia heterophylla* by 1% caustic soda in cold.

(iv) *Agaves and Furcraea*.—Different species of *Agaves* planted last year from our old plantation at Chinsurah have all been established.

Most of the *Furcraea* seedlings raised in our farm from the bulbils received from Mauritius have been transplanted in a permanent site. They are at present growing satisfactorily.

4. Seed Multiplication

Seeds of different fibre crops under observation were multiplied during the year at Nilganj farm on a small scale.

II. ANATOMICAL AND CYTOLOGICAL STUDIES

1. Anatomical studies

(i) *Study of distinguishing features of fibre bundles in jute substitutes and characteristics of ultimate fibre cells.*—

Fibres of jute and substitutes were treated with iodine and different grades of sulphuric acid from 50% to 80%. Slight differences in reaction were found but not sufficient enough for differentiating the fibres. Staining with aniline chloride and conc. HCl has not yielded any tangible results. Treatment with phloroglucinol and conc. HCl gave different colours which can be utilised for identification. The fibres stain crimson initially but fade to light colours in *Hibiscus* species and retain bright colour in *Sida*, *Abroma*, Jute and intermediate colour in *Urena* for longer period.

(ii) *Development of axillary buds.*—The development of axillary buds was studied in Sunn-hemp, *Urena lobata*, *Sida*, *Hibiscus sabdariffa*, var. *altissima*. The development of buds in all these cases is axillary as in variety D154 (*C. capsularis*). In *Sida*, there is a slight developmental peculiarity. The bud is axillary in origin and meets, more or less simultaneously, the leaf and axis near the axil region. There is a space between the petiole and the bud as if the bud is held in a hollow petiole.

(iii) *Meshiness in substitutes*—In order to study the degree of meshiness in jute and substitutes, the length and breadth of the rays in tangential sections of the fibrous regions were studied. The degree of meshiness is studied in the outer and inner regions.

Values for 7 types are given in Table XXXVIII.

TABLE XXXVIII.

		Exterior		Interior	
		Length (mm)	Breadth (mm.)	Length (mm.)	Breadth (mm.)
<i>Abroma</i>	...	3.38	0.86	1.93	0.33
<i>H. Cannabis</i>	...	4.63	0.58	3.23	0.25
<i>H. sabdariffa</i>	...	6.78	1.42	4.91	0.56
<i>C. capsularis</i>	...	6.39	1.02	3.79	0.43
<i>C. olitorius</i>	...	5.80	1.14	4.35	0.39
<i>Urena</i>	...	5.23	0.66	2.78	0.27
<i>Sida</i>	...	2.91	0.60	1.50	0.22

2. Cytological studies

Pollen grain and pollen tube studies have been done in different species of *Hibiscus* and their measurements and percentages of sterility have been worked out.

For the induction of polyploidy in *H. cannabis*, treatment with colchicine has been done both on the seed and seedlings with different concentrations and timings. The morphological peculiarities and the percentage of mortality in these colchicine treated plants have been recorded and the flower buds were fixed for meiotic study.

Fixation of pistils at different intervals after pollination in some of the interspecific crosses along with their controls has also been done to study the pollen-tube growth in these crosses.

At metaphase I, 18 II were observed in *H. radiatus* and tetrad formation found to be normal. The chromosome number of the species is $2n = 36$.

Cytological studies of the parents and F_1 s of the inter-specific crosses between *Hibiscus radiatus* X *H. cannabinus* were also in progress.

III. DISEASES AND PESTS.

(1) Diseases.

A. *Hibiscus cannabinus*.

(a) *Virus diseases*: *Virus A*—The study of transmission has become difficult in the absence of an insectary. The malformations due to virus attack were recorded. A number of selections for resistance were made from the different types. None of the selections were found to be entirely immune.

Virus B—The severe type of chlorosis as reported last year, also appeared this year in an epidemic form. The pigmented types showed partial resistance. A number of selections were made for further study.

(b) *Stem-rot of mesta*: (i) A large number of diseased plants were examined. A strain of *Rhizoctonia* was found to be associated. The *Rhizoctonia* from 'mesta' attacked jute plants and hence it is assumed for the present that the fungus is *R. bataticola*. No pycnidial stage has yet been found in mesta.

(ii) *Phoma sabdariffa* was found to attack leaves and sometimes even stems of mesta.

(iii) The *Helminthosporium* and *Cercospora hibisci* from mesta reported last year were isolated.

(c) *Brown-rot*—Incidence of 'brown-rot' was low in comparison to that in the previous year. The disease started in the first week of August and subsided by the third week. During flowering it was observed that the plants were quite free from disease. Inoculation with pure cultures of *Volutella* isolated from diseased material, produced similar symptoms under laboratory conditions.

B. *Sunn-hemp*—The selections made for wilt resistance were grown in plots known to be infected. Five selections were made for further studies.

C. *Roselle*.—Records from manurial trials did not show any differential incidence in the different treatments.

D. *Furcraea*.—The *furcraea* plants, raised from *anthracnose* infected bulbils obtained from Mauritius and subsequently treated with mercuric chloride, remained free from disease during the whole year.

E. *Ramie*.—A new disease has been observed in ramie plots. A species of *Curvularia* and one of *Alternaria* have been isolated from the affected leaves. Work on this is in progress.

(2) Pests.

Agrilus acutus.—The spiral borer reported in the previous year as *Agrilus* sp. has been indentified as *A. acutus* Thunb. The borer, in the course of the spiral, induces development of an elongated gall. The region of the stem at the level of the gall becomes very weak as there is less lignification of the cell wall of schlerenchyma cells and because of formation of additional new layers of thin walled parenchyma cells. As a result, the stem breaks at the level of the gall when there is sudden gush of strong wind. Portion of the stem above gall dies and dries up after the break. Position of the gall on the stem is therefore, important as it indicates the site of a possible break. The table below shows that plants with height ranging from 6 ft.—8 ft. are subject to more damage and the gall lies nearer the base of the plant. The break, thus, usually occurs near the base of the plant and hence the entire plant is lost after the break.

TABLE XXXIX

Height group of plant in ft.	Distance of gall from base in inches							Total
	Up to 6·0	6·1-12·0	12·1-18·0	18·1-24·0	24·1-30·0	30·1-36·0	36·1-42·0	
Up to 4·0	2	...	1	...	...	...	...	3
4·1-6·0	30	19	5	2	...	...	...	56
6·1-8·0	25	31	22	7	3	2	1	91
8·1-10·0	8	13	19	10	4	5	2	61
10·1-12·0	...	4	3	2	3	...	...	12
Total ...	65	67	50	21	10	7	3	223

The pest has since been recorded in different varieties of *H. cannabinus* and *H. sabdariffa*.

Insect Transmission of Mesta Virus.

In connection with the insect transmission study of mesta virus, collection of insects from virus affected crops was made. Of the various insects, one jassid and one white fly were kept under close observation. The jassid which is common to both *H. cannabinus* and *H. sabdariffa* has been identified as *Empoasca devastans* Dist.

In absence of space, insectary etc., only preliminary tests could be carried out to find out if this is a vector species or not. Indications suggest that *E. devastans* may not be a vector of the disease.

White fly (Aleurodidae) has been found in mesta, roselle and also in jute. The insect is awaiting specific identification. Only a few virus transmission tests could be carried out with this species but the results are inconclusive.

XI. GREEN MANURING

To study the effect of green manuring on jute or paddy or on both jute and paddy under West Bengal conditions a model scheme of the I.C.A.R. on "Improvement of Green Manuring Crops" sanctioned for a period of 5 years was taken up in 1953-54. The main aim of the scheme is to study the agronomical aspects of green manuring. As the season was far advanced when the sanction was received and as no staff under the scheme could join in time, preliminary trials to study the trend of various aspects of green manuring were undertaken. Out of one assistant and two fieldmen sanctioned under the scheme, one fieldman joined in July, 1953 and the other in December. About a month later one fieldman left the department and the post remained vacant for the rest of the year. The assistant joined on 31-12-53.

The following studies were undertaken during the year under report.

1. *Collection of samples of various green manuring crops*—Thirty one different samples of green manuring seeds were collected from different parts of India and grown in observation plots. Pillipesara, a new introduction from Madras showed good performance so far yield of green matter is concerned. Cowpea, kalai and mung though inferior to dhaincha (*Sesbania*) also showed good promise.

2. *Studies on the possibilities of growing G.M. crops between standing jute rows* : (i) *Observational studies*—Nineteen different G.M. crops were sown with last two intercultures between standing jute rows in observation plots. Jute crop was quite high when the G.M. crops were sown and therefore none was found to do well. Earlier sowings between jute rows of shorter height tended to give slightly better yield of cowpea, kalai and mung in respect of green matter.

(ii) *Effect of G.M. crops alone or when sown between standing olitorius and capsularis jute rows on yield of wheat*—(a) A trial was conducted to study the effect of green manuring from G.M. crops when sown alone or intercropped between *olitorius* jute rows on yield of wheat. The treatments included dhaincha, cowpea and mung each sown singly and between standing *olitorius* jute crop with last interculture followed by wheat. Treatments, wheat alone and wheat after jute were also included in the trial.

Dhaincha when sown alone gave the highest green matter. Cowpea gave better result than other G.M. crops when sown between standing jute rows. But the highest yield of wheat was recorded when sown after cowpea alone. Cowpea or dhaincha when sown between standing jute rows gave equally good results with that of dhaincha or cowpea when sown alone. Statistically there was no difference.

(b) G.M. crops tried were sunn-hemp, dhaincha and cowpea sown pure or between standing *capsularis* jute rows. The yield of wheat was more from cowpea sown pure and green manured. Dhaincha, cowpea or sunn-hemp sown earlier between standing jute rows and jute tops incorporated

tended to give equally good results with that of cowpea sown pure so far as the yield of wheat is concerned. Jute tops alone also gave higher yield of wheat.

3. *Date of sowing and age of G.M. crops for incorporation on yield of paddy*—The treatments included four dates of sowing at 20 days interval commencing from 7-5-53 and 3 ages of G.M. crops—75 days, 55 days and 35 days old for dhaincha, cowpea and sunn-hemp. Treatments with paddy as control and paddy after jute were also included. Early sown crop with longer vegetative period yielded more green matter. The treatments showed no marked differences on yield of paddy.

4. *Study of comparative efficacy of green manures alone or in conjunction with fertilizer on yield of paddy*—The treatments included two G.M. crops—dhaincha and cowpea either fertilized or not fertilized followed by the main crop—paddy. Fertilizer application was made by a mixture of 20 lb. N + 50 lb. P_2O_5 + 25 lb. K_2O per acre basis. Application of fertilizer was done to (1) G.M. crops direct, (2) to G.M. crops at the time of incorporation, (3) half quantity to green crops and the other half direct to paddy and (4) to paddy direct. One treatment with paddy alone without green manure crops or fertilizer and another treatment with jute followed by paddy were also included in the trial.

Highest yield was obtained from paddy when fertilizer (single dose) was added direct to paddy. Green manuring either alone or in conjunction with fertilizer seem to have no better effect than fertilizing paddy direct.

5. *Paddy yield as influenced by green manuring alone or together with other manures*—To study the effect of organic and inorganic manures when added at the time of incorporation of G.M. crops, a trial was conducted on a simple randomized layout. The treatments included ammonium sulphate, oil cake, F.Y.M., compost, sludge (at 20 lb. available nitrogen), super-phosphate (50 lb. P_2O_5) and lime (200 lb. per acre) used along with dhaincha (G.M.) when incorporated in the soil, followed by paddy. Treatments

with paddy alone and paddy after dhaincha green manured were also included. The treatment with G.M. and compost was found significantly superior to G.M. and super-phosphate or G.M. and oil cake, but none was found significantly superior to control.

XII. EXTENSION WORK ON IMPROVED METHODS OF JUTE CULTIVATION

With the object of demonstrating and extending the improved methods of cultivation of jute in the cultivators' fields, a pilot scheme was taken up at three centres, Barrackpore, Baraset and Basirhat in the district of 24-parganas, West Bengal. Demonstrations were confined to a radius of five miles from each centre, the target being 30 acres (10 acres in each centre). Use of improved varieties, improved cultural methods like line sowing, proper manuring and double and triple-cropping practices were included as far as possible.

Out of 10 acres scheduled for extension work in each centre the programme was as follows:—

- (a) *Three acres low land*—double-cropped with *capsularis* jute and aman paddy.
- (b) *Four acres mid land*—2 acres each with *capsularis* and *olitorius* jute—triple-cropped with jute, paddy and pulses.
- (c) *Three acres high land*—double-cropped with *olitorius* jute and pulses or any rabi crop.

The work on extension was started with existing staff of the Jute Agricultural Research Institute in addition to their normal duties. Agronomist, Jute Agricultural Research Institute was in-charge of the scheme. Selection of approved cultivators and sowing of the first crop jute were completed in all the 3 centres by the existing Jute Agricultural Research Institute staff. Out of 3 fieldmen sanctioned

under the scheme only one joined in July, 1953 at Baraset centre after the sowing of the first crop was over. Due to the urgency of work at Basirhat centre which is about 35 miles away from the Jute Agricultural Research Institute farm, a fieldman from the Substitute Fibre Section was transferred at the beginning of the sowing season.

Sowings were completed in 60 cultivators' fields out of which twelve failed due to various reasons and 48 trials were successfully conducted. The average cultivation charges for jute was Rs. 230/- with an average yield of 16.23 and 18.22 md. of fibre per acre for *capsularis* and *olitorius* respectively. The net profit from the first crop—jute sown in lines was Rs. 133/- and Rs. 190/- for *capsularis* and *olitorius* respectively. Paddy as second crop recorded an average yield of 20 md. grain per acre. The cultivation charges averaged at Rs. 95/- yielding a net profit of Rs. 97/- from grain and straw combined. Pulses yielded on an average 9 md. per acre giving a net profit of Rs. 59/-.

The demonstrations in all the 3 centres at Barrackpore, Baraset and Basirhat were effective. The cultivators from demonstration centres and adjoining areas appreciated the utility of improved methods and were convinced of the extra profit derived. This is evident from the fact that some of the cultivators approached the staff at all the 3 centres for guidance and instructions as also for taking up trials in their respective plots in the coming season.

Production of improved seeds at the J.A.R.I. Farm

The demand for improved seeds is ever on the increase both from the jute growers and the jute growing States who want it mainly for multiplication in their own farms.

A total quantity of 60 maunds 31 seers 12 chataks of improved seeds has been produced in the J.A.R.I. Farm. For shortage of land at the farm of the Institute it has not been possible to multiply more seeds. The names of the

varieties and the quantities of seeds produced are shown below.

Variety				Quantity		
<i>C. capsularis</i>				Md. sr. ch.		
1.	C39-212	...	...	11	36	0
2.	C41-13	...	...	2	5	0
3.	JR48-1	...	...	1	5	0
4.	C42-Kj-321	...	...	1	15	8
5.	D154	...	...	3	14	0
6.	Fanduk	...	...	2	19	8
Total for <i>capsularis</i>				22	15	0
<i>C. olitorius</i>						
1.	O40-632	...	...	24	19	12
2.	O40-753	...	...	6	8	0
3.	O39-620	...	...	1	21	0
4.	C.G.	...	...	6	8	0
Total for <i>olitorius</i>				38	16	12
Total				60 md, 31 sr. 12 ch.		

After meeting the requirements of the Institute, the seeds were distributed mainly to the various jute growing States for multiplication in their State farms and also to some private organisations.

Multiplication of improved seeds on a large scale will be taken up with the establishment of the proposed Nucleus Jute Seed Multiplication Farm at Panagarh.

A total quantity of 5 mds. 20 sr. of improved strains of *Hibiscus sabdariffa* was produced. After meeting the requirements of the Institute, small quantities were supplied to the State Governments as per their requisition and about 3 mds. were distributed to the cultivators.

LIBRARY

The Institute maintains an up-to-date research and reference library for the use of its members and also for scientific workers attached to different sections of the Indian Central

Jute Committee. During the year under report good number of research workers from different scientific institutions and also some post-graduate students of the Calcutta University made use of the library.

The library has a valuable collection of about 3500 volumes including some rare publications. It receives about 110 scientific journals from different parts of the world, of which 75 are received on payment of subscription, 20 on exchange basis and the rest are complimentary.

During the year under report, 152 books besides a number of Government Publications and other pamphlets were added to the library. 1070 books and periodicals were issued on loan to the members of the staff.

MISCELLANEOUS

Dr. B. C. Kundu, Director, Jute Agricultural Research Institute presided over the Section of Botany, Forty-first Indian Science Congress held at Hyderabad in January, 1954.

Enquiries.—During the year under report a large number of reviews and enquiries relating to jute and substitute fibres were received for comments. Relevant answers were communicated to the various interested parties.

Changes in the staff.—The following appointments were made during the period.

Sri S. N. Sen—Statistician ... 6-3-54

Sri M. N. Shandilya—Assistant, Green
Manuring Scheme ... 31-12-53

Sri P. N. Naha—Junior Mycological
Assistant ... 7-8-53

Visitors.—Sri R. A. Kidwai, Union Minister for Food and Agriculture, Government of India kindly visited the Institute on the 2-10-53 and showed keen interest in the activities and progress of the Institute and expressed great satisfaction about its achievements.

A number of distinguished personalities visited the Institute on different occasions during the year and showed their interest in the progress and achievements.

Sri Arun Chandra Guha, Deputy Minister to the Government of India, Ministry of Finance;

Hon'ble Mr. James Sinclair, Minister of Fisheries, Canada, along with Mr. E. M. Reid, High Commissioner for Canada, New Delhi;

Sri H. M. Patel, I.C.S., Secretary to the Government of India, Ministry of Food and Agriculture.

Sri K. R. Damle, I.C.S., Additional Secretary to the Government of India, Ministry of Food and Agriculture and President, Indian Central Jute Committee.

Members of the Estimates Committee of the Parliament:

Sri Mohanlal Saxena, M.P.

Sri Balwantraji Mehta, M.P.

Sardar Lal Singh, M.P.

Sri Thakurdas Bhargava, M.P. and

Sri Upendra Nath Burman, M.P.

Members of the Jute Enquiry Commission:

Sri K. R. P. Aiyengar, I.C.S., Jt. Secretary, Ministry of Finance, Government of India (Chairman).

Sri P. S. Gupta, Dy. Director General, Supplies (Member).

Sri G. Sandilya, Jt. Director of Finance, Railway Board (Member).

Sri T. S. Seshakutty (Secretary) along with

Sri A. P. Mathur of Ministry of Commerce, Government of India.

Among the other distinguished visitors were:

Sri K. Sen, I.C.S., Secretary to the Government of West Bengal, Department of Agriculture, Co-operation, Forests, and Fisheries;

Mr. I. G. Kennedy, Vice-President, Indian Central Jute Committee ;

Sri J. Dayal, Jt. Secretary to the Government of India, Ministry of Finance;

Sri R. L. Mehta, I.A.S., Dy. Secretary to the Government of India, Ministry of Food and Agriculture ;

Sri V. S. Tilak, I.A.S., Director of Agriculture, Orissa ;

Dr. B. S. Kadam, Director, Tobacco Research, Indian Central Tobacco Committee ; and

Sri M. Sarkar, Dy. Secretary to the Government of West Bengal, Department of Agriculture.

PUBLICATIONS

The following is a list of papers published or sent for publication during the year :—

1. Das Gupta, B. & Ghosh, K.—Genetics of *Corchorus* (Jute). Part VII. Genetics of wavy (undulate) margin leaf character in *C. capsularis*. Indian Journal of Genetics and Plant Breeding. (In press).
2. Datta, A. K. & Saha, S. B.—Wood anatomy of the genus *Corchorus*. Proceedings of the Indian Science Congress, 1954.
3. Datta, R.M.—Pollen grain morphology in genus *Corchorus*. Proceedings of the Indian Science Congress, 1954.
4. Datta, R. M.—Chromosome numbers of some types of *C. capsularis* Linn., *C. depressus* Linn., *C. Christensen* and *C. olitorius* Linn (wild)—Jute Bulletin, Volume 17, No. 3, 101, 1954.
5. Datta, R. M.—Tricotyledony in *Corchorus capsularis* Linn. Science and Culture. (In press).

6. Dutt, N. & Mitra, S. D.—Gall formation and damage in *H. cannabinus* Linn. Science & Culture. Vol. 20, No. 1, 1954.
7. Ghosh, T. & George, K. V.—A short note on *Sclerotium rolfsii* (Sacc.) and its perfect stage. Indian Journal of Agricultural Sciences. (In press).
8. Kar, B. K. & De Sarkar, B. K.—Physiology of fibre growth in Jute (*Corchorus*). II. Variations in pure fibre content at different stages of growth by chemical determination. Proceedings of the Indian Science Congress, 1954.
9. Kar, B. K. & Mazumdar, S. K.—Physiology of flowering in Jute. Proceedings of the Indian Science Congress, 1954.
10. Kundu, B. C.—Origin, development and structure of important vegetable fibres. Presidential Address, Section of Botany, Forty-first Indian Science Congress.
11. Kundu, B. C.—Increase in production and improvement of the quality of Indian jute. Jute & Gunny Review, May, 1953.
12. Kundu, B. C.—‘Jute’. Silver Jubilee Volume of Indian Council of Agricultural Research. (In press).
13. Kundu, B. C. & Chakraborty S. C.—A preliminary note on different nutrient content of different varieties of jute grown under some conditions. Proceedings of the Indian Science Congress, 1954.
14. Kundu, B. C. & Kar, B. K.—Physiology of fibre growth in Jute III. Variation in the growth of wood in relation to bark. Proceedings of the Indian Science Congress, 1954.
15. Kundu, B. C. & Mukherjee, M. K.—Does jute cultivation exhaust the soil? Indian Farming 3, 10, 1953.
16. Kundu, B. C. & Mukherjee M. K.—Jute and Soil fertility. Jute Bulletin 16, 9, 1953.

17. Kundu, B. C., Mukherjee, M. K., Kundu, A. K. & Halder, G.—Biochemical changes during retting of *C. olitorius* (O40-632) Proceedings of the Indian Science Congress, 1954.
18. Kundu, B. C. & Rao, N. S.—Origin and development of axillary buds in Jute (*C. capsularis*). Annals of Botany. (In press).
19. Mukherjee, M. K., Kundu, A. K., Chakraborty, S. C. & Halder, G.—Role of Jute (*Corchorus* sp.) leaves in the maintenance of fertility of jute soils. Science & Culture, 19, 9, 1954.
20. Mukherjee, M. K., Kundu, A. K., Chakraborty, S. C. & Halder, G.—Jute and Soil. Preliminary observations on composting of thinned out jute plants for maintenance of soil fertility. Jute Bulletin, 16, 10, 1954.
21. Mukherjee, M. K., Kundu, A. K., Chakraborty, S. C. & Halder, G.—Preliminary studies on soil nitrogen status due to cropping with jute. Proceedings of the Indian Science Congress, 1954.
22. Rao, N. S. & Kundu, B. C.—The effect of maturity on the dimensions of ultimate fibres of jute. Proceedings of the Indian Science Congress, 1954.
23. Sanyal, A. T.—Growing jute as a row crop and its possibilities. Jute Bulletin. 1953.
24. Sanyal, P. and Datta, A. N.—Natural crossing in *H. sabdariffa*. Science & Culture, 19, 407, 1954.
25. Sanyal, P. and Datta, A. N.—Inheritance of leaf character in *H. sabdariffa*. Science & Culture. (In press).

B. C. KUNDU,
Director, Jute Agricultural
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STAFF

A list of the staff is given below:—

1. Director ... Dr. B. C. Kundu, M.A., Ph.D.
(Leeds), F.L.S., F.N.I.

Agronomical Section

2. Agronomist ... Vacant.
3. Assistant ... Sri B. K. Das, B.Sc. (Ag.).
(Remained in charge of the
Section during the period
under report).
4. —do— ... Sri D. B. Dua, B.Sc. (Ag.).

Botanical Section

5. Botanist ... Sri B. Das Gupta, M.Sc.
6. Assistant Botanist ... Sri B. Roy, M.Sc., (Cal.),
M.Sc., (Lond.).
7. Assistant ... Sri M. S. Sarma, M.Sc.
8. —do— ... Sri K. L. Ghosh, B.Sc., B.Ag.

Anatomical Section

9. Anatomical Assistant ... Sri N. S. Rao, M.Sc. (Ag.).
(Incharge).
10. —do— ... Sri A. K. Datta, M.Sc.
11. Jr. Anatomical Asstt. ... Sri S. B. Saha, B.Sc.

Physiological Section

12. Physiologist ... Dr. B. K. Kar, M.Sc., Ph.D.
(Liepzig).
13. Assistant ... Sri S. K. Mazumdar, M.Sc.
14. Jr. Assistant ... Sri B. K. De Sarkar, B.Sc.

Cytogenetical Section

15. Cytogeneticist ... Dr. G. I. Patel, B.Sc. (Ag.),
M.S., Ph.D. (California).
16. Assistant ... Sri R. M. Datta, M.Sc.

Mycological Section

17. Asstt. Mycologist ... Sri T. Ghosh, M.Sc.
 18. Assistant ... Sri M. Basak, B.Sc.,
 19. Jr. Assistant ... Sri P. N. Naha, B.Sc.

Entomological Section

20. Asstt. Entomologist ... Sri N. Dutt, M.Sc.
 21. Assistant ... Sri S. D. Mitra, M.Sc.
 22. Jr. Assistant ... Sri S. P. Bhattacharjee, B.Sc.

Chemistry Section

23. Assistant Chemist ... Dr. M. K. Mukherjee, M.Sc.,
 Ph.D.
 24. Microbiological Asstt. ... Sri A. K. Kundu, M.Sc.
 25. Chemical Assistant ... Sri S. C. Chakraborty, M.Sc.
 26. Biochemical Assistant ... Vacant.
 27. Jr. Chemical Assistant ... Sri G. S. Halder, B.Sc. (Offi-
 ciating as Biochemical
 Assistant).

Statistical Section

28. Statistician ... Sri S. N. Sen, M.Sc. (Since
 6-3-54).
 29. Assistant ... Vacant.

Substitute Fibre Section

30. Assistant Botanist ... Vacant.
 31. Assistant ... Sri P. Sanyal, M.Sc., Assoc.
 I.A.R.I. (Remained in
 charge of the section during
 the period under report).
 32. —do— ... Sri A. N. Dutta, B.Ag.

Library

33. Librarian ... Sri A. K. Sur, M.Sc., Dip. Lib.

Farm

34. Farm Manager ... Sri P. K. Das, B.Sc., B.Ag.

Office

35. Head Clerk & Accountant ... Sri R. Chakrabarty, B.A.
 36. Artist ... Sri T. D. Nag, B.A.

APPENDIX.

Programme of work as sanctioned.	Progress of work in 1953-54.	Future programme of work in 1954-1955.
I. BREEDING & GENETICS OF JUTE.		
1. Collection of varieties and types including wild species of <i>Corchorus</i> .	Plants raised from 8 Indian and 7 foreign samples of jute were studied. 56 primary selections were made from promising materials.	To be continued.
	Two samples of wild seeds from U. P. and Madras were grown. The former failed to germinate. We have at present in our collection 7 wild species of <i>Corchorus</i> including the wild forms of <i>C. capsularis</i> and <i>C. olitorius</i> .	— do —
2. Breeding of improved strains of jute.	Nine progeny-row trials, six <i>capsularis</i> and three <i>olitorius</i> including two trials of X-irradiated materials were conducted and 3572 secondary selections were made in these trials. 30 cultures from <i>capsularis</i> and ten from <i>olitorius</i> trials were carried forward. These included 11 cultures from X-irradiated materials.	— do —
	<i>Varietal trials</i> .—Two varietal trials, one <i>capsularis</i> and one <i>olitorius</i> , were carried out during the year. The <i>capsularis</i> trial included some new varieties.	— do —
	Among <i>capsularis</i> strains, C39-212 and CT-919 gave 11 and 8 per cent respectively higher yield than the control D154. Fanduk and C42-Kj-321 were superior to the other varieties in respect of quality ratio.	
	The improved strains of <i>olitorius</i> , O40-753, O39-620 and O40-632 gave 23, 18 and 18 per cent respectively higher yield than the control C. G.	
	<i>Varietal trials in State farms</i> .—12 varietal trials—two each of <i>capsularis</i> and <i>olitorius</i> in W. Bengal and one of each in the rest of the States were sown. The data from only 2 <i>capsularis</i> trials in W. Bengal and 1 <i>olitorius</i> trial in Assam were received but all the three, on scrutiny were found to be unsuitable for analysis. Data of one <i>capsularis</i> trial in Orissa are yet to be received. The rest of the trials failed due to various reasons.	— do —

Programme of work as sanctioned.	Progress of work in 1953-54.	Future programme of work in 1954-1955.
Subvention trials in cultivators' plots.	All the 85 trials planned were sown—30 in W. Bengal, 16 in Bihar, 16 in Assam, 13 in Orissa and 10 in U. P., of which 18 <i>capsularis</i> and 14 <i>olitorius</i> trials were successful. Of the <i>capsularis</i>, C42-Kj-321 in Assam, JR48-1 in W. Bengal and C41-13 in Orissa gave 26, 20 and 14 per cent respectively higher yields than the locals. Of the <i>olitorius</i> strains, O40-632 proved best in W. Bengal yielding 31 per cent higher than the locals.	To be continued.
Polyploidy in Jute.	Germination in the <i>capsularis</i> polyploids of the 1948 series was extremely poor. None of the two available plants set seed. Progenies of plants of the 1950 treatment maintained their characteristic polyploid features. Single plant and bulk seeds, where available, were carried forward. Progenies of the 4 <i>olitorius</i> tetraploid lines of 1950 maintained their characteristic morphological features. Only pods containing the highest number of viable seeds were selected for sowing. Germination in three of the four lines ranged between 42 and 47 per cent and the fourth recorded only 29 per cent. 131 selections were made in the <i>capsularis</i> and <i>olitorius</i> polyploid lines for further studies. A large number of interspecific crosses between the polyploid forms of the two species were attempted resulting in a few settings. These developed into apparently normal looking capsules but failed to yield viable seeds.	Polyploids of the two species to be preserved as breeding materials and fertility to be increased.
Studies on irradiation of jute with X-rays.	X_2 generation—19 <i>capsularis</i> and 10 <i>olitorius</i> aberrant selections brought forward from the X_1 generation of the previous year were grown. Among the <i>capsularis</i>, only three cultures gave progenies that showed some degree of variation as compared to the normal. Of the <i>olitorius</i>, only a few plants in three of the cultures showed some variation at the advanced stage of the vegetative phase.	To be continued.

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955.
Vegetative rapprochement as a means of overcoming interspecific cross incompatibility in jute. 3. Inheritance of characters. Genetic strains. Isolation of full-green genotypes.	44 selections were made from the <i>capsularis</i> and <i>olitorius</i> cultures for further studies. <i>Fresh treatments of seeds.</i>—Dry and pre-soaked seeds of both <i>C. capsularis</i> (C89-212) and <i>C. olitorius</i> (O40-632) were treated afresh with soft X-rays during the year. Lower dosages affected mostly leaves while plants raised from seeds treated with higher dosages showed variations in the stem, leaves and the reproductive organs. 429 <i>capsularis</i> and <i>olitorius</i> selections including some promising materials were made for further studies. 16 Fourth generation grafts employing cleft, inarch and splice methods of grafting were successful. Seeds obtained from both stocks and scions of 11 grafts were carried forward. 36 interspecific crosses between grafts of the two species were attempted. A number of crosses developed into normal-sized capsules but none of them yielded any viable seed. All progenies of 92 selections carried forward from the true breeding cultures of the previous year bred true to their parental characters. 495 selections were made in these cultures for further study. The performance of 64 selections brought forward from the purification series of the previous year was studied. In all, 142 selections were carried forward. 51 test crosses were sown along with 18 selections of parents for confirmation of the full-green genotypes. 6 full-green genotypes, reported earlier were confirmed and carried forward. Routine test crosses were also made to test the purity of the full-green parents.	To be continued. True breeding strains already isolated to be maintained. Isolation of new strains to be continued. To be continued.

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955.
Leaf variants- <i>Capsularis</i> .	Six fresh crosses made for isolation of some of the remaining genotypes were also grown. Four F_1 selections were carried forward. <i>Deeply serrated, female-sterile type</i>.—18 out of 23 normal selections from heterozygous families of the previous year segregated into normal and variant progenies. Progenies of all the segregating families were classified at intervals of a fortnight.	To be continued.
Inheritance of leaf shape and size in <i>C. capsularis</i> .	<i>Crumpled leaf type</i>.—Seeds of a crumpled leaf mutant isolated from one of the C39-212 plots of the previous year were grown. The progenies bred true to the parent. To study the inheritance of this character, crosses were made with the normal leaf types. The crosses and parents were carried forward.	— do —
Inheritance of leaf shape and size in <i>C. capsularis</i> .	Leaves of the F_1 progenies of crosses between broad and narrow leaf types were almost narrow, those of crosses between broad and normal leaf types were normal while those of crosses between normal and narrow leaf types were intermediate. 38 successful back crosses, F_1 progenies and their parents were carried forward.	— do —
Seed-coat colour in <i>C. olitorius</i> .	The back crosses and F_2 families were studied and the progenies were classified into different seed-coat colour groups. A number of promising F_2 progenies were carried forward for inclusion in progeny trials.	— do —
Inheritance of plant height.	The F_1 progenies of crosses between tall and dwarf parents in <i>C. capsularis</i> and <i>C. olitorius</i> were intermediate in height. 25 successful back crosses, F_1 progenies and parents were carried forward. Fresh crosses were also made between the improved <i>olitorius</i> strains and the wild forms of <i>olitorius</i>. Crosses and parents were carried forward.	— do —

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955.
Inheritance of earliness in <i>C. capsularis</i>.	The F₁ progenies of crosses between Maniksari, an early type and D154, a late type, were intermediate in maturity. 12 successful back crosses, F₁ progenies and their parents were carried forward. 64 fresh crosses covering combinations of early, medium and late types were also obtained. All the crosses and their parents were carried forward.	To be continued.
II. ANATOMICAL STUDIES		
Developmental anatomy of axillary buds.	In <i>Corchorus siliquosus</i> and <i>C. olitorius</i>, the buds originate in cauline position but develop ultimately into axillary buds.	Completed.
Structure and quality of fibre in jute.	Jute fibres show four to six layers, each one being composed of two to six subsidiary layers. The principal layers alternate with each other whereas the subsidiary layers maintain one direction only. As in cotton balloons develop in jute when lignin is removed.	The length of the ultimate fibres in several varieties of <i>capsularis</i> and <i>olitorius</i> will be studied. Length will also be measured in previously tested yarns.
Study of formation of fibre layers in relation to plant height and base diameter.	The number of fibre bundles in cross section showed corresponding relationship with the fibre content of the plant in five varieties of <i>C. capsularis</i> in pre-bud stage but could not be confirmed in bud stage.	To be continued.
Routine identification of fibre samples.	Several fibre samples received were identified and reports submitted.	To be continued.
III. CYTOLOGICAL INVESTIGATIONS.		
1. Interspecific hybridization.	Interspecific hybridization was carried out by using a number of varieties of <i>C. capsularis</i> and <i>C. olitorius</i> including their wild types in both directions.	To be continued.

Programme of work as sanctioned.	Progress of work in 1953-54	Future programme of work in 1954-1955,
Study of factors involved in incompatibility between <i>C. capsularis</i> and <i>C. olitorius</i> in crosses.	After pollinating <i>C. capsularis</i> (D154) and <i>C. olitorius</i> (C. G.) and vice versa 10 pistils were fixed at different intervals ranging from 5 minutes to 4 days.	To be continued.
2. Cytological studies.	Haploid chromosome numbers in <i>C. olitorius</i> (wild), <i>C. depressus</i> , unidentified Aden material, Kalichar, Deodhali, Halmahera and D154X variant n are 7.	— do —
3. Colchicine treatment and X-irradiation in Jute.	(a) Cytological studies of certain individuals of $2n \times 4n$ population of <i>C. Olitorius</i> (C. G.) were done. Chromosome number varies from 20-23. Seedling treatment by hanging drop method was found to be suitable. 0.25% aqueous solution of colchicine is drastic in both the seed and the seedling treatment. (b) Pollen of <i>C. olitorius</i> and <i>C. capsularis</i> were irradiated with different doses of X-rays and was used in pollinating flowers of the same variety. Cytological analyses of certain plants of <i>C. capsularis</i> and <i>C. olitorius</i> raised from X-irradiated seeds were completed.	— do —
4. Pollen grain studies.	Morphological studies on the pollen grains of several varieties of <i>C. capsularis</i> , <i>C. olitorius</i> and <i>C. tridens</i> , were carried out.	To be continued with other new species and varieties.
IV. PHYSIOLOGICAL INVESTIGATIONS.	1. Investigations on the physiology of jute seeds. (i) Viability efficiency of seeds collected at different stages of maturity. Detailed results on different varieties at different stages of maturity in relation to seed setting and germination have been worked out. The results have been correlated with different stages of harvest, when seeds as well as fibre may be profitably obtained from the same plant.	
		To be continued.

Programme of work as sanctioned.	Progress of work in 1953-54	Future programme of work in 1954-55.
(ii) Investigations on the "Dualpurpose" of harvesting jute.	The above results have been tested under field conditions. Harvests at three stages were taken and the yield of fibre of the whole plant as compared to the yield of fibre in plants from which the top portions were removed, have been compared. The results along with the quality ratios of such fibres have been discussed.	To be continued under field conditions.
(iii) Performance of jute seeds collected from plants grown in off-season in winter.	As previously found with D154 and Chinsura green, winter grown plants of O40-632 and C39-212 were stunted and produced few capsules, seeds from which, however, gave normal plants.	To be continued with other important varieties.
2. Nature and Range of flowering and seed-formation.		
(i) Nature of flowering.	The work was continued with D154, Fanduk, Jap Red, C42-Kj-321, C39-212, Chinsura Green, R26, O39-620, O40-632 and O40-753. Under identical conditions of sowing, <i>capsularis</i> varieties flowered earlier than <i>olitorius</i> varieties. The flush of flowering and range of flowering period varied in the two species.	Completed.
(ii) Number of seeds formed in <i>capsularis</i> developed at different times of flowering period and their viability efficiency.	Results on seed setting obtained along with the studies on the nature and range of flowering in the above varieties indicate that seed setting is associated with the nature of flowering period.	Completed.
	The seeds obtained from the above experiment were tested for germination. Seeds collected from capsules developed in the earlier weeks of the flowering period gave higher percentage of germination than those collected from capsules developed at later periods of flowering.	To be continued in detail.
3. Effect of vernalization and photoperiods on the initiation of the reproductive phase in jute.	The experiments were repeated with other varieties. Vernalization (pre-sowing cold treatment) and different photo-periods (as post sowing treatment) were given. Earliness in flowering was induced under short day periods and lateness in flowering under long day	To be continued to assess the degree of response to temperature and different photoperiods in different varieties.

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955.
	periods. Post sowing photoperiods were more effective in determining the initiation of flowering than pre-sowing cold treatment.	
4. Salt-resistance experiments.	Experiments were carried out in the farm under various salt-concentrations by treating the seeds before sowing as well as in the seedling stages. The results indicate a slight increase in salt toleration in case of treated seeds. The experiments are being continued with seeds collected from salt treated parent plants.	To be continued as per programme.
5. Root system in jute species.	The studies were repeated with other varieties—Jap Red, C39-212, O40-632 and O40-753. The specific differences noted earlier as to the length of the tap-root, spreading and volume of secondary roots under Nilganj soil conditions were confirmed.	Completed.
6. Variation in growth and pattern of unit structures contributing towards the yield of fibre.	The unit structures such as phloem pyramids, fibre bundles per pyramid and layering of fibre bundles per pyramid were studied at various stages of growth. It was concluded that higher yield of O39-620 over C.G. was more dependent on the increased number of layers formed and consequently greater number of fibre bundles per pyramid than on the number of well-formed pyramids.	To be continued along with growth studies.
7. Investigations on growth in different species and varieties of jute with reference to moisture content bark and fibre growth and wood formation during the life cycle of the plant.	The work on the various aspects of growth was continued on D154, Fanduk, Jap Red, C42-Kj-322, C39-212, C. G., O39-620, O40-753, O40-632 and R26. The results have been discussed under different sub-heads.	Completed.
(i) Variations in growth of pure fibre at different heights of the stem and at different stages of plant growth.	At all the stages of growth, more fibre was formed in the basal regions than in the apical portions. Variation of growth components showed the interdependence of fibre formation and flowering behaviour, which are different in the two species.	To be continued.

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-55.
(ii) Distribution of pure fibre in bottom, middle and top region of the stem.	Further results on this aspect have been obtained. A comprehensive view of the distribution of pure fibre in three regions has been made in almost all the important varieties.	Completed.
(iii) Percentage variation in the distribution of pure fibre.	Results obtained on Chinsura green and O39-620 along with those already obtained on other varieties give an idea of the nature of distribution of pure fibre in terms of growth of other components like wood, bark, green weight and dry weight.	To be continued.
(iv) Ratio of bark formation to that of wood formation.	From the results on the growth components given above the ratio of bark and wood formation was obtained. The variations of these two important factors, which determine the yield of fibre at different stages and at different heights of the growing stem, have been analysed.	To be continued.
8. Growth sequence in relation to stalk and foliage.	Further results have been obtained on the variations of green weight in terms of growth of stem and corresponding output of leaves.	-do-
9. Comparative studies in the physiology of growth of fibre in branching (D154) and non-branching (Jap Red) varieties of <i>capsularis</i> jute.	Results show that the percentage distribution of pure fibre in terms of different components indicates no marked differences which could be traced back to the branching or non-branching habit of the two varieties.	Further peculiarities, if any, will be studied.
V. JUTE AGRO-NOMY		Sand culture experiments at different nutritional levels.
1. Spacing-cum-variety-cum-manuring trials on jute <i>capsularis</i> and <i>olitorius</i> .	In <i>capsularis</i> the combined treatment effect was significant at 1 per cent level. The results show that the main effects due to spacing and manuring were significant. The application of nitrogenous manures increased the fibre yield considerably. The highest yield was obtained from the late variety (D154) sown in lines with inter spaces—3' x 12' with addition of manure; the per cent increase recorded being 28.1 over that of broadcast.	To be continued.

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955
2. Manurial trials (a) Effect of N. P. K. on <i>capsularis</i> and <i>olitorius</i> jute. (b) Effect of organic and inorganic nitrogen on jute (<i>capsularis</i> and <i>olitorius</i>). (c) Time of application of ammonium sulphate in jute (<i>capsularis</i> and <i>olitorius</i>). (d) Comparative merits of nitrogenous fertilizers and manures on jute (<i>capsularis</i> and <i>olitorius</i>).	Significant effects were recorded in different manurial treatments in both the <i>capsularis</i> and <i>olitorius</i> trials. The application of N gave higher yields of 29.28% to 59.63% in case of <i>capsularis</i> and 17.97% to 32.25% in <i>olitorius</i> over the control (no manure). The differences due to various treatments were not significant though higher proportion of inorganic sources tended to give a little better result in the <i>capsularis</i> trial. Due to adverse weather conditions and stunted growth of crop, the <i>olitorius</i> trial was abandoned. The treatment differences in <i>capsularis</i> trial were significant. Instalment application of ammonium sulphate at the time of sowing and at second weeding gave the highest yield. No significant responses were obtained in <i>olitorius</i> trial. In <i>capsularis</i>, application of Chilean nitrate and ammonium sulphate recorded significantly higher yield than F. Y. M., sludge and control (no manure). Chilean nitrate alone proved significantly superior to ammonium sulphate-nitrate and no manure. No significant differences in the various treatments were obtained in <i>olitorius</i>.	To be continued. To be continued. —do— To be continued in a modified form. Separate trials for organic sources and inorganic sources of nitrogen will be taken up.
3. Manurial trials in cultivators' plots in the jute growing States.	Simple manurial trials in non-acid and acid soils were conducted for the third year in the various jute growing States. In acid soils in Bihar, lime alone or in combination with nitrogen increased the yield of jute considerably. Application of nitrogen at 20 lb. and 40 lb. N per acre in non-acid soils of all jute growing States was found to increase the yield from 20.7% to 28.3% and 36.5% to 53.2% over the control	Modified trials with inclusion of potash and phosphate singly or in combination with higher doses of nitrogen will be conducted in the non-acidic soils.

Programme of work as sanctioned.	Progress of work in 1953-54	Future programme of work in 1954-1955.
4. Triple-cropping Experiments. (a) Nilganj, Barrackpore. (b) At Chinsura Govt. Agriculture Farm.	respectively. The extent of increase from application of ammonium sulphate varied from State to State. Jute gave higher fibre yields with later stages of crop harvests. For the same period of growth, late variety (D154) gave slightly higher yields than the early variety (Fanduk) of jute. In case of paddy as second crop, earlier transplanting, gave higher yields than late transplanting. Growing of jute as an earlier additional crop did not depress the yield of paddy appreciably provided paddy was transplanted by the first part of August. Both Jute and paddy gave positive responses to manurial treatments. Pulses as third crop failed due to lack of moisture. Later stages of harvest of jute gave higher fibre yields. The yield of paddy as second crop seemed to be unaffected by growing of jute as an earlier additional crop. Higher profit was obtained from growing jute and paddy in the same land than cropping the land with paddy alone.	To be continued.
5. Date of sowing with jute (<i>capsularis</i> and <i>olitorius</i>)	April sowing recorded the highest yield of fibre in both <i>capsularis</i> and <i>olitorius</i>. Sowings done either earlier or later than April gave poorer yields in both <i>capsularis</i> and <i>olitorius</i>. Late varieties of both <i>capsularis</i> and <i>olitorius</i> proved significantly superior to early varieties.	—do—
VI. SOIL, BIO-CHEMICAL & MICROBIOLOGICAL STUDIES. 1. Quality of fibre.	In addition to iron and tannin, the part played by the pH of the retting water in producing the shamla colour of fibre has been tentatively determined.	—do—

Programme of work as sanctioned	Progress of work in 1953 54	Future programme of work in 1954-1955.
	The removal of the shamla colour by treatment with different organic and inorganic acids has been successful under laboratory conditions. 2% tamarind extract may prove most effective and economical. Work has been started to study the effect of varietal and soil factors on the quality of jute.	To be continued. —do—
2. Retting of jute. A. Action of different activators on retting of jute.		
Synthetic and natural activators. B. Survey of retting water.	Residual effect of bone dust and ammonium sulphate in combination has been observed to be more in case of <i>capsularis</i> than <i>olitorius</i>. For the same volume of water, greater quantity of jute stems can be retted when activators are added. A concentration of 100 p.p.m. of B, Mo, Zn, Se, Co, Mn, Mg and Cu are toxic and retting period is usually reduced at a concentration of near about 10 p.p.m. of these activators in some cases and in some other cases reduction of retting period has been observed at a concentration of 1p. p.m. For want of laboratory accommodation, no detailed work could be done on the micro-organisms responsible for retting. The mixed culture which gave encouraging results was maintained. 42 samples were obtained from different places and were studied.	—do— —do—
C. Retting without steeping.	Under fully anaerobic condition, there is no retting and under partial anaerobic conditions, there is retting.	—do—

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955.
D. Biochemical changes during retting.	Many of the biochemical changes were found to be similar during the retting three varieties of—D154, C39-212 and C. G.	To be continued
E. Isolation of specific micro organisms responsible for retting.	Three cultures of previous year were maintained. Of the 58 cultures brought forward from the previous years, only the two cultures showing retting properties have been maintained. Fungi from different sources are being collected for extraction of extra-cellular and intra-cellular pectinases.	— do —
3. Analysis of soils and manures for their chemical and mechanical constituents		
(a) Routine analysis.	31 samples were analysed.	— do —
(b) Soil survey.	132 soil samples obtained from different States and extension plots of J. A. R. I. were analysed for pH., organic carbon, available phosphates and exchangeable bases.	Mechanical analysis is to be done of these soil samples and further work to be continued as other samples are received during the year.
4. Soil exhaustion studies.		
A. Soil exhaustion studies in double cropping plots.	Results are similar to those of last year, <i>i. e.</i> , if jute be harvested earlier, the soil-nitrogen status is better, and if jute or jute and paddy be grown, the available soil nitrogen is more after paddy than if paddy be grown alone.	To be continued.
B. Soil exhaustion by different varieties of jute.	No marked differential exhaustion or changes in the soil properties have been found after the second year's crop. The varieties studied were C39-212, D154, C. G. and O40-632.	— do —

Programme of work as sanctioned	Progress of work in 1953-54	Future programme of work in 1954-1955.
C. Changes in nutrient status of soil.		
(a) In heavily fertilized land.	When a mixture of ammonium sulphate and sodium nitrate is added, pH has generally fallen. In case of ammonium sulphate, amount of exchangeable calcium has also fallen. There has been no increase of organic matter in super-phosphate treated plots. In compost treated plots, organic carbon has generally increased.	To be continued.
(b) Soil nitrogen:		
(i) Chemical	After cropping with jute for one year, the total nitrogen has not fallen. It has rather increased. After cropping for two years, in all the plots studied, there has been an increase of total nitrogen. Jute compost, as a source of nitrogen, compares favourably with town compost or sludge.	-do-
(ii) Microbiological.	Fluctuation of fungi, total bacteria and azotobacter in manured and unmanured plots with or without jute is more or less like that observed during last year.	-do-
(c) Soil phosphorus.	Alkali soluble phosphates increase after a crop of jute. Available phosphates also increase more or less after two years' continuous cropping with jute alone. Jute compost is a good source of phosphate and is better than many organic manures.	-do-
D. Withdrawal of nutrients by the jute plants.		
(a) Accumulation of inorganic nutrient ions in the tip leaves (shoot apex).	Concentration of nitrate nitrogen is very low while that of ammonia nitrogen is considerable.	-do-
(b) "Uptake" of total nitrogen by the plant.	About 50-100 lb. of nitrogen are removed by the crop which is harvested. The removal is more in manured plots than in unmanured ones.	-do-
		Uptake of other plant nutrients will be studied.

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5. Development of methods for determination of nutrients for advisory work in connection with manuring etc.	0.15 normal sulphuric acid method for available phosphate was standardized and effect of storage is being studied. Attempts are being made to develop a rapid method for estimation of available nitrogen.	To be continued.
6. Role of soil conditions regarding susceptibility to diseases	Some indirect evidence has been obtained on the possible influence of Boron in producing or controlling diseases. An experiment has been started with different doses of B, Zn, Cu, Mn, Mo and Co to study their influence on diseases.	— do —
7. Attempts to find out maximum production of jute under the influence of nitrogen.	The yield was not statistically significant.	—do—
8. The influence of soil conditioners on soil textures.	A field experiment was carried out with Krilium, tamarind seed powder, silicates, composts etc., and it has been found that Krilium and tamarind seed powder have improved the waterholding capacity of soils.	—do—
VII. DISEASES.		
1. Study of the effects of environmental factors on secondary infection due to <i>Macrophomina phaseoli</i> .	Data confirmed the previous finding that infection is always limited to the basal leaves where starch accumulates. Estimation of starch, however, did not show difference between susceptible and resistant types. In the earlier sowings of the date of sowing experiments, pycnidia formation on the stem, which is a serious potential source of secondary spread of disease was noted.	
		— do —

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2. Study of the stem rot fungus.		
(i) Study of the different isolates of <i>Macrophomina phaseoli</i> and <i>rhizoctonia</i> on jute and potato.	Pure cultures of <i>M. phaseoli</i> were less potent against jute than inoculum from diseased plants. It was found that <i>M. phaseoli</i> infected potato tubers under field condition.	To be continued
(ii) Classification of the physiological strains, if any.	8 isolates were studied under field and laboratory conditions. It was found that B43 from "Memari" and B 59 from "Tarakeswar" were 2 distinct virulent forms which were physiologically different from Nilganj strain.	—do—
3. Study of the biology of pathogens other than <i>M. Phaseoli</i> .		
(i) Anthracnose of Jute.	The developmental symptoms were classified ; 3 selections which proved to be highly resistant were made. Bordeaux mixture was found to be very effective in checking infection. The pathogenic nature of <i>Colletotrichum</i> has again been proved against jute. It is found to be seed borne.	To be continued along with the study of the incidence in different varieties of <i>C. capsularis</i> and <i>C. olitorius</i> .
Detailed developmental studies, selection for resistance, breeding and work on control of the disease.		
(ii) Soft rot.		
Studies on the development and epidemiology of 'soft-rot'.	Artificially multiplied sclerotia were used as a source of inoculum in a field trial. Such sclerotia did not induce the disease.	Incidence of disease in general.
(iii) <i>Fusarium</i> . Inoculation studies on 3 <i>olitorius</i> types and anatomical studies on diseased specimens.	Pure culture of the <i>Fusarium</i> sp. could infect all varieties only in the seedling stage under laboratory conditions. But in field, it did not induce any disease. Anatomical studies indicated the presence of fungal hyphae in the roots of affected plants.	To be continued
4. Investigations on chlorosis in jute.	It has been found that chlorosis is transmitted through seed and also by grafts of the crosses between chlorotic and non chlorotic plants in both directions, those between non-	—do—

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5. Investigations on the methods of control of diseases.	chlorotic x chlorotic failed to germinate and the F_1s from chlorotic x non-chlorotic were found to be all chlorotic. The genetical portion of the work is being carried out by the Botanical Section.	
(i) Selection and Breeding of resistant types.	87 selections were made from <i>C. capsularis</i> and <i>C. olitorius</i> types. The F_1s were grown and mortality and infection rates were recorded. Fresh crosses were also made.	To be continued
(ii) Susceptibility of different capsularis varieties to diseases.	From the records of incidence of disease obtained from the large scale varietal trials, it is gathered that the new type CT919 has proved relatively more resistant.	— do —
(iii) Susceptibility due to nitrogenous fertilizers.	In plots manured with equivalent quantities of ammonium sulphate and sodium nitrate, it was observed that <i>C. capsularis</i> was more susceptible to collar-rot and root-rot than <i>C. olitorius</i> under Nilganj conditions. The differences between manured and unmanured plots were not significant.	— do —
(iv) Studies on the relative efficacy of various commercial copper fungicides.	It was found that seed treatment with Agrosan GN gave partial but effective protection against secondary attack in seedling stage. Perenox and Bordeaux were found to be significantly superior as sprays.	—do—
(v) Effect of application of lime in root-rot areas.	In Tarakeswar area where epidemic root-rot breaks out every year, selected plots showed marked improvement by application of lime for 3 successive years.	—do—
(vi) Effect of rotation with paddy to be continued.	A plot at Tarakeswar centre, which had 100% root-rot in 1951 was cropped with paddy in 1952 and 1953. Jute will be grown in the next season.	Results of growing jute after 2 years of paddy cultivation will be studied.

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6. Effect of increase in population on incidence of disease.	A spacing of 5" x 12" in row-crop has been found to be good from prophylactic point of view. Application of manure did not show that closer spacing could be adopted with benefit.	To be continued.
7. Storage of seeds.	It was found that jute seed deteriorated very fast when it came in contact with air. The 'alkathene' bags, now available in market, were found suitable for storing jute seeds in viable condition for two seasons.	Concluded.
VIII. PESTS.		
1. Study on <i>Nupserha bicolor</i> ssp. <i>postbrunnea</i> .		
(a) Whether endemic or exotic.	Existence of a very favourite indigenous weed host <i>Sesbania aegyptiaca</i> suggests that the species is endemic and not an exotic type.	
(b) How introduced to jute.	It is very likely that with extension of jute cultivation, the insect has been introduced from the weed host— <i>S. aegyptiaca</i> to jute. It has now established itself as one of the major pests of <i>olitorius</i> jute.	Effect of N, P, K & their combinations on the incidence of the pest.
(c) Genital organ of the female.	Genital organ of the female presents many remarkable modifications adapted for oviposition inside the stem tissue. Mandibles cut the rings and the slit on the stem.	Effect of spacing-cum-varietal-cum-manuring on the incidence of the pest.
(d) Larval/adult stages and damage.	Larval or the adult stages are not associated with damage. Their feeding has no noticeable adverse effect on the host.	
(e) Influence of temperature in initiating larval diapause.	Larval diapause is not influenced by temperature. It appears that diapause is obligatory.	
(f) Effect of common insecticides on adult.	Laboratory trials show that both BHC and DDT are effective against adults.	Study on the residual effect of insecticides in preventing <i>Nupserha</i> damage.
2. Studies on <i>Neocatolaccus</i> .	Preliminary observation on the life history of the parasite has been made. It has been found that the parasite was responsible for parasitizing 31.56% of <i>Nupserha</i> population.	

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	Its maximum activity was noted during the month of August. Parasites <i>Ipobracon</i> sp., <i>Goryphus</i> sp. <i>Spathius</i> sp. together parasitised 5.79 per cent.	To be continued.
3. Study on <i>Apion corchori</i> .	No significant difference was noted amongst selections including X-irradiated selections of both <i>capsularis</i> and <i>olitorius</i> . Apion incidence was more in early sown crops.	—do—
4. Study on <i>Laphygma exigua</i> .	Incidence of <i>L. exigua</i> was limited to early sown crops.	
5. Study on <i>Anomis sabulifera</i> .	Crops sown during May suffered more damage by this pest than crops raised during other periods of the season.	Study on the different larval instars in relation to crop damage.
6. Study on <i>Hemitarsonemus latus</i> .	Incidence of <i>H. latus</i> was found more in early sown crops.	
IX. SUBSTITUTE FIBRES		
1. Botanical and Agronomical studies.		
Collection of types.	18 fresh samples of seeds and other propagative materials of different fibre crops were received during the season.	To be continued.
Studies on <i>Hibiscus</i> sp.		
1. Breeding and genetics.		
(i) Isolation and selection of types.	223 selections in <i>H. cannabinus</i> were brought forward from the purifications series and grown. 169 of these selections have been found to be breeding true. 500 further selections and 250 fresh selections were made. In <i>H. sabdariffa</i> , 73 selections made made from the 115 non-bristled selections were carried forward. 152 other selections grown were found	—do—

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(ii) Interspecific hybridization.	to be breeding true with regard to various characters. 252 further selections have been made from these cultures. 10 F₁ families of the last year's interspecific crosses between <i>H. radiatus</i> x <i>H. cannabinus</i> were grown for observation and 50 back crosses were attempted. 800 fresh interspecific crosses between different species of <i>Hibiscus</i> have also been attempted. Quite a good number of successful crosses between <i>H. radiatus</i> x <i>H. cannabinus</i> have been obtained.	
(iii) Small scale trial of <i>Hibiscus cannabinus</i> .	The experiment was conducted like last year. The observed differences in the yield of fibre were significant.	To be continued.
(iv) Varietal trial of <i>H. sabdariffa</i> .	The type MH-2 has given the maximum fibre yield, but it was at par with all the other varieties except Goldcoast.	To be continued. Two progeny trials in <i>H. sabdariffa</i> will be conducted.
(v) Anthocyanin pigmentation.	In <i>H. cannabinus</i>, anthocyanin pigmentation study could not be made due to extremely poor germination of all the F₂ and back cross families. In <i>H. sabdariffa</i>, 207 F₂ families and 101 back cross families for pigmentation study were grown and classified.	To be continued.
(vi) Inheritance of earliness.	37 F ₁ families of the cross between early x late strains of <i>H. cannabinus</i> were grown and studied. 10 back crosses and 25 fresh crosses were also obtained	— do —
(vii) Leaf shape character.	A monogenic difference between palmately-lobed and partially-lobed type of leaf was observed in <i>H. sabdariffa</i> .	Completed.
2. Agronomic studies.		
(i) Date of sowing experiment.	This experiment was conducted in replicated randomized block with both <i>H. cannabinus</i> and <i>H. sabdariffa</i> var. <i>altissima</i> , sown at intervals of 14 days and necessary observations were recorded.	To be continued.

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(ii) Seed-rate experiment with <i>H. cannabinus</i> .	The differences with respect to stand per acre, average plant height, base diameter, green weight and fibre yield were highly significant.	To be continued.
(iii) Seed-rate experiment with <i>H. sabdariffa</i> .	No significant differences have been obtained between the different seed rates with respect to green weight and fibre yield.	— do —
(iv) Spacing trial with <i>H. sabdariffa</i> var. <i>altissima</i> .	The highest fibre yields were obtained with 6" spacings within the line irrespective of spacings between the lines.	— do —
(v) Trial of spacing-cum-stages of harvest with <i>H. sabdariffa</i> var. <i>altissima</i> .	The test was insignificant.	— do —
(vi) Manurial trial with <i>Hibiscus sabdariffa</i> .	The test was insignificant.	— do —
(vii) Yield trial with different fibre crops.	Roselle (G. P.) has given significantly higher yield of fibre than that of jute (D154), Mesta (Gr. 5) and <i>Malachra capitata</i> .	— do —
3. Studies on other fibres.		
(i) Sunn-hemp.	Morphological characteristics of the different collections were recorded.	— do —
	The plant of <i>Crotalaria anagyroides</i> are continuing its vegetative phase for the last seven months.	— do —
(ii) Linseed.		
(a) Agro-botanical characteristics.	Agrobotanical characteristics of the different Flax X Linseed hybrid collections were recorded.	— do —
(b) Yield trial of Linseed strains.	Flax tall X Linseed N. C. 3 has given the highest yield of both straw and seed.	
(iii) Ramie and other nettle fibres.	Fresh plantation of ramie slips obtained from cuttings and also seedlings raised from seeds have been done.	— do —
	Chemical degumming of ramie fibre with 6% sulphuric acid in cold	

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	followed by bleaching has been found to be both economic and practical. <i>Girardinia heterophylla</i> has been successfully extracted by 1% caustic soda in cold.	
(iv) <i>Agaves</i> and <i>Furcraea</i> .	Different species of <i>Agaves</i>, planted last year have all been established.	To be continued.
4. Seed Multiplication.	Transplantation of <i>Furcraea</i> seedlings in a permanent site has been completed.	— do —
II. Anatomical and Cytological studies.	Seeds of different fibre plants under observation were multiplied on a small scale.	
1. Anatomical studies.		
(i) Study of distinguishing features of fibre bundles in substitutes and characteristics of ultimate fibre cells.	Different grades of sulphuric acid, aniline chloride and HCl, and phloroglucinol and HCl were tried on jute and substitutes. Only phloroglucinol and HCl yielded colour reaction that helps in identification of the fibres.	— do —
(ii) Development of axillary buds.	Development of buds in <i>Urena</i>, <i>Sida</i>, Sunn-hemp and <i>Hibiscus sabdariffa</i> var. <i>altissima</i> has been found to be axillary.	Completed.
(iii) Meshiness in substitutes.	The length and breadth of rays as indicating the degree of meshiness were studied in important substitutes. Further work will be taken up when corresponding values of degree of splittability are available from T. R. L. tests.	To be continued.
2. Cytological studies.	Developmental studies.	
	Pollen grain and pollen tube studies have been made in different species of <i>Hibiscus</i>. Morphological peculiarities in the different colchicine treated plants of <i>H. cannabinus</i> were recorded.	To be continued.

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III. Diseases and Pests. 1. Diseases. A. <i>Mesta</i>. (a) Virus diseases. (b) Stem-rot. (c) Brown-rot. B. <i>Sunn-hemp</i>. C. <i>Roselle</i>. D. <i>Furcræa</i>.	Fixation of pistils after different periods of pollination in some of the interspecific crosses of <i>Hibiscus</i> have been done. The chromosome number of <i>H. radiatus</i> was found to be $2n=36$. Cytological studies of the parents and F₁s of the interspecific cross, <i>H. radiatus</i> x <i>H. cannabinus</i> were also in progress. No work was possible on this line as the proposed insectary could not be fitted up. A number of selections were made for further study. <i>Rhizoctonia bataticola</i> has been found to attack <i>Mesta</i> causing collar rot. Both <i>Helminthosporium</i> and <i>Cercospora</i> have been isolated in pure culture. The development of the disease was studied and the optimum period of infection was found to be from first to third week of August. Results of the study of chemical sprays were not conclusive. The selections for wilt resistance were grown in infected soil and 5 secondary selections were made. No differential response of diseases were observed in the manurial trial. The infected bulbils imported from Mauritius remained free from diseases after subsequent treatment with mercuric chloride.	Will be taken when insectary is fitted up. Further selection and breeding will be done. Incidence of the disease in various type plots will be recorded. Inoculation studies will be made with all the isolates. To be continued. The selections will be grown for further observation and selection. To be continued. Work on development of disease will be undertaken.

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E. Ramie.	A new disease has been observed in Ramie plots.	Study of the incidence of disease and isolation of pathogen, if any.
2. Pests.		
<i>Agrilus acutus</i> .	<i>A. acutus</i> has been found to be an important pest of <i>H. cannabinus</i> . It induces development of an elongated gall. The region of the stem at the level of the gall becomes very weak. This often results in breaking of the stem when there is strong wind. The entire plant is lost after the break. The pest has been found on different varieties of mesta and roselle.	Observation on the biology of the pest. Difference of <i>H. cannabinus</i> & <i>H. sabdariffa</i> on the incidence of the pests. Effect of different dates of sowing of mesta on the incidence of the pest.
Insect transmission of mesta virus.	Preliminary observations on the insect fauna from the vector point of view, were made. One jassid has been identified as <i>Empoasca devastans</i> . Preliminary tests carried out by this insect suggest that it may not be a vector species. One white fly (Aleurodidae) is under observation.	To be continued.
<i>Green Manuring</i> 1. Collection of samples of various G. M. crops.	Plants raised from 31 different types collected were studied in observation plots.	— do —
(i) Observational studies.	Nineteen different G. M. crops were sown under standing jute rows along with the last two interculturalings given and studied. Cowpea, mung and kalai tended to give slightly better results than others. Earlier sowings of G. M. crops between comparatively shorter jute plants in rows seemed to give a little better response.	— do —

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(ii) Effect of G. M. crops alone or between standing <i>olitorius</i> and <i>capsularis</i> jute rows on yield of wheat.	In <i>olitorius</i> plots highest yield of green matter was obtained from dhaincha when sown pure, but the yield of wheat was more from cowpea sown pure and green manured. Cowpea and dhaincha sown either pure or between standing jute rows and green manured were not significantly different as regards the yield of wheat. In <i>capsularis</i> plots yield of wheat was slightly more from cowpea sown pure and green manured. Dhaincha, Sunn-hemp and cowpea intercropped with jute and jute tops incorporated in soil also tended to increase the yield of wheat.	Same as above on yield of wheat.
3. Date of sowing and age of G. M. crops for incorporation on yield of paddy.	Earlier sown G. M. crops with longer vegetative period gave more green matter. No appreciable differences on yield of paddy were noticed from different treatments.	Two dates of sowing and two stages of incorporation for G. M. crops sown alone or intercropped with jute on yield of paddy.
4. Comparative efficacy of G. M. crops alone or in conjunction with fertilizers on yield of paddy.	Under Nilganj conditions, green manuring either alone or in conjunction with fertilizers seemed to have no better effect on paddy yield than fertilizing paddy direct.	To be continued with slight modifications.
5. Paddy yield as influenced by green manuring alone or together with other manures.	Treatments included addition of each of ammonium sulphate, compost, sludge, F. Y. M., oilcake, superphosphate and lime to G. M. crop (dhaincha) when incorporated in the soil. Paddy alone and paddy after dhaincha green manured were also included in the treatments. None of the treatments were found significantly superior.	Manures and fertilizers alone will be tried against cowpea and dhaincha green manured separately.
EXTENSION WORK	Extension on improved methods of jute cultivation was carried out in 3 centres at Barrackpore, Baraset and Basirhat in 24 Parganas of West Bengal. Sowing jute in lines, uses	To be continued.

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	of manures and improved jute seeds, double and triple cropping practices were taken up in all the three centres. Sowings were done with 60 cultivators fields—one half with capsularis jute and other half with olitorius jute. Forty eight trials were successfully conducted. Average cultivation charges for jute was Rs. 230/- for an average return of 16.23 to 18.22 maunds of dry fibre. Net profit obtained from jute (line sown) was Rs. 133/- to Rs 190/- per acre. Paddy as second crop yielded 20 maunds of grain on an average costing Rs. 95/- as cultivation charges. Yield from pulses was 9 md. per acre giving a net average profit of Rs. 59/- per acre.	

